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About the Journal

Impact and Policy Research Review (IPRR) (e-ISSN: 2583-3464) is a biannual research journal managed and published by IMPRI Impact and Policy Research Institute, New Delhi. IPRR hosts written contributions on topics having concrete implications for progressive development, covering a well-grounded policy analysis, that is interdisciplinary or focused on particular disciplines, for example, Economics, Politics, Governance, Geography, Sociology, Gender and Ethnic Discrimination, Development Studies, Environmental Degradation, Anthropology, and International Relations, with an expectation that all work is accessible to readers across the social sciences.

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EDITORS' NOTE

Impact and Policy Research Review (IPRR)

Volume 1 Issue 1 (January-June 2022)

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Over the past year, India witnessed two waves of COVID-19, where the second wave unleashed brutal implications on all aspects of individual, familial, societal, economic, and national life. With different mutations and variants of coronavirus emerging in different parts of the world, the pandemic threat continues to loom large. The rapid development of vaccines and massive vaccination drives offer a silver lining. In this context, the hopes of easing COVID-19 restrictions and unlocking the various sectors of the economies lie.

In light of the above, we are happy to present to the readers Issue 1 of Volume 1 of Impact and Policy Research Review (IPRR), a flagship journal of IMPRI Impact and Policy Research Institute. It is divided into the following sections: Insights, Policy Perspectives, Special Articles, Young Voices, and Report Review. The articles provide an in-depth analysis of the grassroots-level realities and make room for further introspection and analysis in a pandemic-ridden world. These articles propose unbiased policy recommendations and address the underlying objectives of IPRR to demonstrate evidence and action-based research. We hope that the articles in this Issue would greatly benefit the social science research community and policymakers and foster healthy deliberations of development policies and decisions in India and the world.

We thank the Journal Advisory Board and Editorial Review Committee for their enthusiastic support for the journal. We congratulate the authors for their insightful and well-researched articles. We also congratulate the IPRR Secretariat for their hard work and for setting solid foundations of high editorial standards for the journal.

With Gratitude,
Editors,
Impact and Policy Research Review (IPRR)

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Insights

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India's communities show self-reliant pathways out of COVID, but is its government listening?

Ashish Kothari[1]

Abstract

With the onset of COVID-19 and the resultant lockdown in India did not impinge upon the economic activities in the Kunariya village in the Kachchh region of western India. This included works under the MGNREGA. During the entire year of 2020, Kunariya did not have a single case of COVID-19 infection, nor did it experience any significant loss of livelihoods, unlike a huge swathe of India that was affected by both. Even during the devastating second wave, those who got infected recovered fully. This article raises an important question as to what made Kunariya resilient to both the health and economic impacts of COVID19, the answer to which is the habit of sincere implementation of schemes, and allocation of funds received from the Union and State governments. It also describes the resilience of the village of Sittilingi in the state of Tamil Nadu. What connects both these cases is the indomitable efforts of elected respresentatives at the Panchayat levels, along with that of sensitive officials, politicians and civil society organizations.

Keywords: COVID-19; Kunariya Village; Sittilingi Village; People's Participation

As news of a strange new viral infection reached it in March 2020, Kunariya village in the Kachchh region of western India swung into action. Even before India's Prime Minister announced a national lockdown on 24th March, the village had already put into place restrictions on entry and movement, physical distancing, wearing masks, and awareness programmes on staying safe. Yet it also insisted on the continuation of economic activities, including works under the country's Employment Guarantee Scheme that enabled the poorest to earn a living wage. Throughout 2020, Kunariya did not have a single case of COVID-19 infection, nor did it experience any significant loss of livelihoods, unlike a huge swathe of India that was affected by both.

But what of the deadlier 2nd wave of 2021, which left millions gasping for breath, and penetrated even villages very far from the urban epicentres of the infection? "We have had a few cases of infection, but all recovered well, and again, we never stopped our livelihood activities", said Suresh Chhanga, the elected

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sarpanch (head) of the village, when I called him up in early June 2021. Vaccinations were also proceeding as rapidly as doses were available; in another couple of months the village was entirely covered.

The above description raises an important question as to what made Kunariya resilient to both the health and economic impacts of COVID19? On a visit to the village in January 2021, in that short interregnum between the first and second waves of infection, I dug deeper into its remarkable story (Kothari 2021). Over the last 2-3 years, Chhanga motivated its panchayat (village council) and young people in the village to optimize the use of funds coming to it from the union and state governments, set up processes and institutions for enhanced people's participation, with particular focus on education, health, livelihoods, water, and regenerating ecosystems. Even in such a short period, this mobilization stood the village in good stead when COVID hit.

Kunariya's story is exceptional, but it is not the only one. 1500 kilometres further south, in the state of Tamil Nadu, the village of Sittilingi has its own tale of resilience. When the neighbouring state of Kerala announced the first COVID case in January 2020, Panchayat President Ms Madheswari called for an urgent meeting with relevant government departments, and a civil society institution called Tribal Health Initiative (THI). The village went into disaster control mode, including mass awareness campaigns, physical distancing in all places of public gathering, and isolation of returning migrants. As an income generation initiative, local tailors were asked to stitch masks in bulk. This panchayat has had many years of inputs by THI[i], an initiative by Drs. Regi George and Lalitha Regi to create an adivasi-oriented health facility, along with organic cultivation, education, empowerment, crafts and other livelihood activities (Vikalp Sangam 2021a).

In 2021, the 2nd COVID wave hit the village much worse. But the community was ready with the necessary awareness programmes on safety protocols people should follow. The THI hospital was converted into a COVID treatment facility. While unfortunately three people lost their lives out of about 450 people who came for treatment, Dr. Regi said: "without the state of readiness and the preventive health work done over the last year, which significantly reduced the inflow of patients, the casualties would have been probably 10-15 times higher". Agricultural activities and the sale of farm and pastoral produce continued, thereby averting economic distress.

Kunariya and Sittilingi represent that fringe of India's communities that have resisted the general trend of health and economic breakdown in COVID times. They provide key lessons for the kind of COVID recovery pathways that India could take. The national network Vikalp Sangam[ii] ('alternatives confluence'), comprising over 70 people's movements and civil society organizations, has put together several dozen such stories from across the country in association with other networks like Mahila Kisan Adhikar Manch (MAKAAM) and Community Forest Rights Learning and Advocacy Network (Vikalp Sangam 2020; Vikalp Sangam 2021a-d; Vikalp Sangam and CFR-LA 2020).

In the central Indian heartland of forest-dwelling *adivasis* (Indigenous peoples), collective rights to the forest have enabled villages to establish community funds. These became a vital source to support migrant workers from these villages who, laid off in the cities, returned home but had nothing to fall back on. Women farmer groups like North-East Network and Deccan Development Society have over the years established local self-reliance in food, and were able to feed their families during the months of economic lockdown. The Mahila Umang Samiti, comprising women self-help groups in 100 villages of the Uttarakhand Himalayan region, was able to procure the produce of 400 farmers, and deliver it to customers. In many of these examples, women have had to challenge old gender and caste inequities, as also re-establish their organic, indigenous seed-based farming.

Groups under Kerala's state-supported Kudumbashree programme, that has provided dignified livelihoods for lakhs of women, worked with panchayats and urban ward sabhas to spread awareness about COVID, set up community kitchens to cater to those needing food aid, and mass produce sanitizers and masks. Goonj, a civil society initiative working in 20 states, reached relief to over 40,000 families, and is using its *Vaapsi* ('returning') programme of restoring livelihoods, to establish localized barter and exchange systems promoting dignified livelihoods[iii]. Youth in many parts of the country went out of their way to help communities tide over the crisis (Vikalp Sangam 2021d). In Kolkata, young members of the NGO Prantakatha mobilized support for 32 elderly homeless widows through their programme *ador* (Bengali for 'deep affection and care'), generating not only relief materials but a sense of community solidarity that kept the women safe.

Other than these, there are hundreds of other initiatives of local self-reliance or self-sufficiency and solidarity in food, livelihoods, water, energy, sanitation, housing, and other basic needs across India. These are initiatives that have significantly reduced distress migration to cities and industrial zones, in some cases even encouraged a return to villages. They teach us that the future of a sustainable and just society lies in *localization* instead of economic *globalization,* that has left hundreds of millions of people across the world in a precarious situation. Such a move could also significantly reduce the need for the frenetic trade and travel that characterizes globalization, and is a major contributor to the climate crisis.

Importantly, these radical alternatives are also about people and communities claiming power where they are, rather than be dictated to by governments and corporations. Various forms of what Mahatma Gandhi called *swaraj* – self-determination and freedom with social and ecological responsibility – can be glimpsed in them. But they are also arenas for challenging the many traditional and new inequities Indian society is riddled with, including patriarchy and casteism. And they show us the power of building on traditional and local knowledge systems, supplementing them with modern knowledge where relevant.

Building on the several examples of such alternatives, the Vikalp Sangam network has come up with a framework of holistic transformation that encompasses political, economic, social, cultural and ecological spheres, with a core of ethical

values like solidarity, diversity, autonomy, non-violence, and rights with responsibilities towards other humans and the rest of nature (Vikalp Sangam 2017). Similar transformations are being increasingly seen in many other regions of the world, though all are still marginal to the dominant exploitative and unsustainable system (Kothari 2021b).

Unfortunately, as with governments in most other parts of the world, the Indian state appears unwilling to learn these lessons. Since mid-2020, Prime Minister Modi has announced a series of COVID recovery packages, labelled *Aatma Nirbhar Bharat* ('self-reliant India'). The name is grand, but in actuality there is little in them to support the kind of self-reliance the above initiatives are demonstrating. Instead, the stimulus plans are ecologically illiterate and dangerous; over 60 new coal mining blocks have been put up for auctioning, many of them in India's biodiversity hotspots and heartlands of Adivasi (indigenous) populations (Kothari 2020a). In fact over the last few years, the Modi government has increasingly privatized the economy, pursuing MoUs with dozens of foreign companies, diluting laws protecting the environment and labour rights, putting heavy tax burdens on handicrafts, and forcibly acquiring land, forest, and other resources vital to the rural economy to hand them over to corporations (Kothari 2020b). This continues a trend started when India announced 'economic reforms' in 1991 under pressure from the International Monetary Fund and the World Bank. In the last 30 years of economic globalization, India's labour force (over 90% of which is in the informal or unorganized sector) has become increasingly insecure, devastatingly vulnerable to crises like the COVID-time lockdowns. According to the Azim Premji University (APU), 230 million Indians have been pushed into poverty in 2020, due to economic lockdowns. Unemployment was already at a high of nearly 6% before the pandemic; it has crossed double digits in mid-2021 (APU 2021).

The public health sector has been systematically neglected; with allocation to it remaining around 1% of the total budgetary outlay, India ranks at 179 out of 189 countries in prioritization of health in the government budget (Kulshreshth 2021). One painfully visible result of this was its inability to cope with the 2nd wave of COVID19 in April-June 2021; its increasing privatization has also taken healthcare out of reach of tens of millions. Agriculture, on which over 50% of India depends for livelihoods, has also received either neglect, or the forcible imposition of corporate control. This includes the promulgation of three laws on agriculture in the middle of the pandemic in 2020, all oriented towards greater commercialisation and private companies, which led to the country's largest ever farmer occupation of the streets around Delhi. This protest continued for over a year till the government finally agreed to promulgate the laws, and meet some of the other demands; as of the time of writing this, farmers are waiting to see if the government actually meets them.

It does not need to be like this. Rather than 'business as usual' disguised in the form of the *Aatma Nirbhar Bharat* packages, the Indian state could have initiated a very different recovery. Statements issued by the Vikalp Sangam platform in both the first and second waves pointed to how this could be so (VSCG 2020; VSCG 2021).

Between agriculture in all its forms and crafts, for instance, and the regeneration and conservation of natural ecosystems and the land, there is a potential to provide dignified livelihoods to 200 to 400 million people. Add decentralized manufacturing and infrastructure, and services, and one could reach the vast majority of India's workforce. Why cannot textiles, footwear, tourism, banking, and most other sectors of production and services, be managed by community enterprises spread across India? Already there are hundreds of examples of this, some from ancient times like handlooms, some new like homestays and community-led tourism, that we can learn from. The re-orientation of the National Rural Employment Guarantee scheme, and its extension to urban areas, could have catered to such sectors. Suresh Chhanga, sarpanch of Kunariya, told me his dream is for the village to produce all items of daily use in the household: "we spend Rs. 4 million *every month* on these, why should we line the pockets of corporations when we can produce it all here?" He is in good company; this was Mahatma Gandhi's dream too, when he spoke of 'village republics' governing themselves and being self-reliant for basic needs.

How would funds be generated for such a recovery package? Economists and social commentators have suggested that a mere 2% wealth tax on the richest 1% of Indians, coupled with an inheritance tax, could generate more revenue _than the total *Aatma Nirbhar Bharat* package (Mander et al. 2020). It would be enough to support universal rights to food, employment, health care, education, old age pension and disability allowance (Jan Sarokar 2020). But a government that has deeply entrenched itself within crony capitalism, is unwilling and unlikely to take such steps.

What India and other countries in a similar situation need is a rainbow new deal, supporting the above kinds of livelihoods (Kothari 2020c). But given that its government is going in the opposite direction, it will have to be communities and people's movements, with whatever help they can get from sensitive officials, politicians and civil society organizations, to use the COVID crisis as an opportunity for moving towards a just, sustainable society.

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[i] https://www.tribalhealth.org/

[ii] www.vikalpsangam.org

[iii] https://goonj.org/support-covid-19-affected/; https://goonj.org/vaapsi-restoring-lives/

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Insights

How has COVID-19 Transformed the Gig Economy in India?

Vivek Kumar[1]

Abstract

The world of work today is witnessing a transformation with the onset of Industrial Revolution 4.0 fuelled by the Internet of Things and Artificial Intelligence. Gig work, though not a totally new phenomenon has picked pace over time and India is among the largest gig economies. The pandemic has further accelerated the growth of the gig economy in India. It is estimated that by 2025 more than 300 million will be doing gig jobs in India standing at about US$ 250 billion. The millennials and the Gen-Z actually prefer doing gig jobs as this provides them with flexibility, better/more satisfying wages and keeps up their pursuit of happiness. It is evident that gig work is here to stay and all research points in the same direction. Governments across the globe have rushed to regulate the sector and the Government of India is not much behind on this, though a lot remains to be done. It is necessary that if such a large proportion of our workforce is going to be in the gig economy, mostly in blue collar jobs, the government makes sure that the interests of these workers are taken care of. The column introduces gig work, its presence/growth in India and makes some recommendations for policymakers.

Keywords: Gig Work; Gig Economy; COVID; Social Security; Gen-Z

Despite the tremendous attention that gig work and gig economy have received owing to the tremendous growth potential it holds, and the traction that it has generated from academicians, unions and policy-makers, a standard definition of gig economy has not yet been globally accepted. Different scholars and policy making bodies in different countries have proposed varying definitions, some as narrow as including only labour transactions via digital platforms while others as broad as including the casual workers/daily wagers that are offered a day job at the roadside. Gig economy could be roughly defined as paid/unpaid tasks/renting carried out by independent contractors/ fixed term employees and mediated by online/offline **platforms.**

[1] Communication Officer, Dattopant Thengadi Foundation (Bharatiya Mazdoor Sangh).

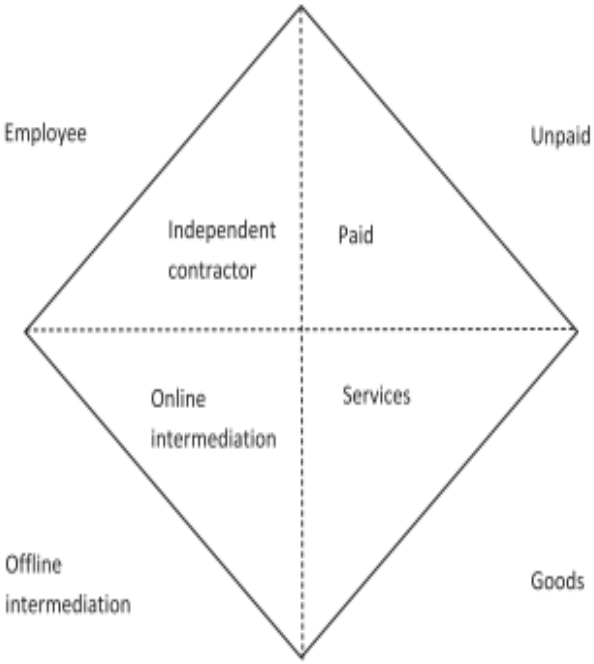

Figure 1: What makes up the gig economy (Koutsimpogirgos et al.)

Government of India, in its social security code - 2020 uses a rather wide but ambiguous definition of a gig worker i.e. '(35) "gig worker" means a person who performs work or participates in a work arrangement and earns from such activities outside of traditional employer-employee relationship;' (The Gazette of India, 2020); which leaves open the debate on what exactly is the gig economy, but it is said without a shred of doubt that the new/next normal is dominated by the gig economy (Sarkar, 2021).

Gig Economy in India

An economy offering temporary, flexible jobs to independent contractors, freelancers and part-time workers, connected mostly through online platforms, has become commonplace. Gig economy in its broadest sense is not a new phenomenon in India but the advent of digital platforms that facilitate/mediate contractual labour/goods transactions have accelerated the growth of gig economy in India and across the world. Both demand and supply side factors in the wake of pandemic induced uncertainty have led to the exponential growth of the gig economy. It is worth noting that participation of labour in the gig economy is higher in developing countries like ours with 5-12% participation compared to the developed countries where it is mostly below 4% (Das). Most of the workers in these sectors are indulged in low-paying blue-collar jobs like ridesharing, food/goods delivery and other microtasks. Currently, India's gig-labour force is around 8 million (Boston Consulting Group and Michael & Susan Dell Foundation, 2021). It is set to grow to almost 24 million in the next three to four years, and it has been estimated that India could

produce as many as 90 million opportunities through gig or platform jobs if it reaches its full potential. Other estimates suggest that India's gig workforce stands at about 15 million currently and is likely to have 350 million gig jobs by 2025 (India Brand Equity Foundation, 2021).

The pandemic that grappled the world, disrupted the supply chains and forced governments to lockdown economies had an equally, perhaps a more severe impact on India. With economic growth already slowing down before the pandemic and unemployment rates substantially higher than normal, the pandemic acted as a catalyst for the growth of the already expanding gig economy. According to a 2020 survey, "India stood to lose almost 135 million jobs, which pushed Indians towards non-conventional forms of jobs i.e. both white and blue collar, freelance jobs" ((Maitra et al.), 2020). Associated Chambers of Commerce and Industry in India (ASSOCHAM) predicted that India's gig sector would stand at US$ 455 billion in 2024 with a compounded annual growth rate of 17% and it has now the potential to grow at twice the rate as predicted before the pandemic (ASSOCHAM, 2021). The Economic Survey 2021 noted that India has emerged as one of the largest markets for flexi staffing in the world due to wider adoption of e-commerce and online retailing (Sirohi, 2021).

Impact of the Pandemic

In the initial days of the pandemic, there were no solutions towards combating the virus, and the only option at hand was prevention. Government of India was at crossroads with the choice of saving lives and saving livelihoods, which ultimately fulfills life and the choice in the given circumstances was obvious and looking in retrospect, correct. India, a predominantly informal economy, witnessed growing unemployment rates with precarity, poverty and inequality increasing every day. Though the government was quick to expand its free ration distribution programme, people struggled to meet even the bare minimum of their needs. They were looking for wage-work. The internet brought this to them. With affordable rates of internet and decent connectivity and advent of digital platforms/applications, work from home jobs, and a reminder of the fragility of life, people's orientations changed, not suddenly but significantly. Millions who were pushed out of the workforce, saw a chance to upskill themselves via the internet and join the freelance jobs that provide both flexibility and better/ more acceptable wages. Emergence of various intermediaries/online mediation platforms made it possible for people to find work from the comfort of their homes and complete the jobs from anywhere with internet connectivity in their own time at their own convenience. The millennial generation, which has just entered/is ready to enter the workforce has fallen in love with the idea of working when they wish to work, from where they wish to be. In its report, ASSOCHAM notes "with talented pools today becoming way more diverse in their age constitution and with millennials and Gen-Z workers increasingly becoming part of the country's workforce, many have begun preferring to become part of the gig

economy" (Sharma, 2021). Home delivery of goods/services (including food and medicine), tele-consultations with doctors accelerated during the pandemic as people were afraid of moving out of their homes. The pandemic has also forced firms and organizations to rethink the very nature of work and remodel themselves.

E-commerce platforms hired thousands of delivery partners during the pandemic. Similarly other firms hired freelancers to perform tasks online. Although the demand for gig-workers has increased since the start of the pandemic, competition for gig jobs has also increased. The gig workers now have competition from former full-time employees as well, who have been forced into gig-work but are mostly better skilled than the full-time gig workers. This has also led to an increase in precarity of work conditions for the gig-workers. During the pandemic their earnings went significantly down, and firms exploited them as other jobs were not available.

Way Forward

It is now an established fact that gig work is here to stay and thus governments must bring forth regulations to protect the interests of all parties involved without hurting any. It is time that firms rethink the role of the gig workers in their organizations and make provisions to retain them/ provide them with benefits, which other workers in the conventional working culture are entitled to. European countries have gradually started to direct firms to recognise gig-workers as employees and render them the benefits accordingly (Chauhan, 2021), but India is still a long way behind.

Government of India has been quick enough to respond to the emergence of the gig economy and has made provisions for its expansion but in the meantime, it has to be kept in mind that economic growth is not an end in itself and that development through adequate distribution/redistribution of created wealth is necessary. It has made provisions for a social security cess from gig/platform firms for social security of gig workers and in the meantime has also started collecting data via the e-Shram portal. The government has announced that the gig/platform workers will also be covered under the Minimum Wage Laws (code on wages - 2019) now (Aryan, 2021).

Regulatory framework has to be developed in due course of time and hiring and firing of workers in the gig economy has to be regulated and the rights (right to work/life) of such workers has to be protected. The government should speed up the process of setting up social security funds for the gig workers and task all stakeholders including the trade union bodies in the sector to administer it.

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Policy Perspectives

Beyond hard interventions: *(Co)managing COVID wastes in urban peripheries*

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Abstract

Solid Waste Management (SWM) is one of the most important public health services which is provided by the Urban Local Bodies (ULBs) across the globe. The key focus of this service is to manage the generated wastes from different sources. With the onset of the Severe Acute Respiratory Syndrome (SARS)-COVID-19 in late December (2019), there is a sudden upsurge in the quantity and quality of waste generation. Most people around the world were locked down in order to prevent the transmission of the virus and have also started to use facemasks, sanitizers, and gloves to remain safe from the COVID-19 virus as per the World Health Organization (WHO) guidelines. With this lockdown scenario, there is a huge increase in the quantity of municipal solid wastes (MSWs) across the planet. With its initial wave, COVID-19 had struck several metropolitan cities. But with the introduction of the second wave, the infection rate affected the peri-urban areas, starting to impose serious challenges to the existing waste management infrastructures.

In this study, by using the empirical research processes mainly the key informant interviews (KIIs) and focus group discussions (FGDs), the key perspectives and performance mechanisms of different stakeholders especially the ULB officials and local community members of three sub-divisional towns of the Hooghly District, West Bengal, namely Chandannagar, Hooghly-Chinsurah and Serampore, have been traced respectively. This study further argues that from those challenges and potentials of those stakeholders, a (co)management framework can be (co)designed and (co)implemented to cope with the COVID waste management problems in the peri-urban areas across India.

Keywords: COVID-19; Hooghly; West Bengal; COVID wastes; (co) management

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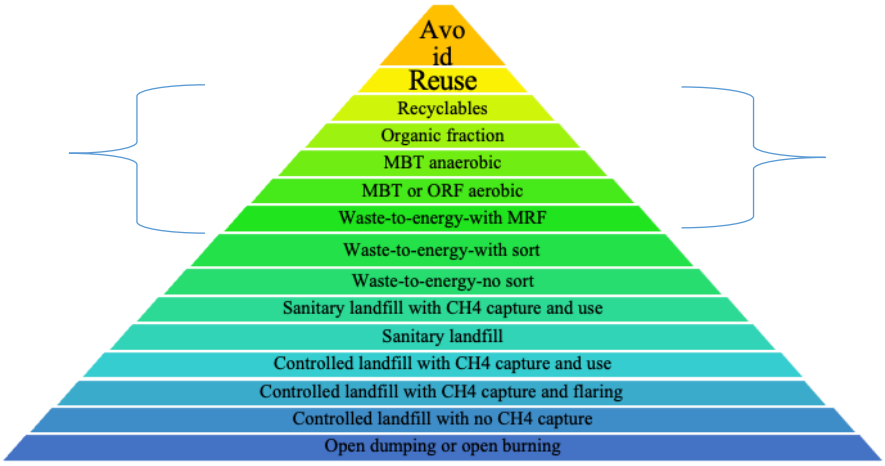
1. Introduction

Solid waste management (SWM) is a public health service provided by urban local bodies (ULBs) whose importance often becomes more apparent following widespread service deficits (Moore, 2009). It is generated on a daily basis which is required to be administered daily and an essential practice adopted by the local authorities to maintain hygienic surroundings in residential areas (Hoornweg and Bhada-Tata, 2012). Urban SWM has long been recognized as a serious environmental issue in developing countries. As we know, municipal solid waste management (MSWM) is one of pivotal ULB services and it represents an inevitable by-product of human activity and a major crisis for communities across the globe. The management includes steps and strategies through which solid wastes are handled by any municipal authority (Fig. 1).

Fig. 1: Conventional MSWM hierarchy



Source: Author (Das), compiled from Alhassan et al., 2018

In late December 2019, the first severe acute respiratory syndrome (SARS)-COVID-19 infected case was recorded in the Wuhan city, China. In mid-March 2020, the World Health Organization (WHO) declared it as a global pandemic. As the pandemic was declared, the countries with identified COVID-19 cases adopted actions recommended by the WHO to slow down person-to-person transmission, such as locking down the educational institutions, stopping non-essential activities, restricting circulation of people, and in more extreme cases, the total isolation of people in their homes. These actions helped in saving lives by breaking the virus transmission chain. (WHO, 2020). In order to treat the COVID-19 affected persons, personal protective equipment (PPE), gloves, masks, sanitizers are imperative. The facemasks became essential and mandatory to remain safe from the SARS-COVID-19. Additionally, the increase in COVID-19 cases raised worries worldwide about the contamination risks associated with SWM mainly focused on bio-medical and household waste, since many diagnosed patients do not need hospitalization, and remain in home isolation. In this latest scenario, the risk of increasing the spread

of the virus through household waste from contaminated individuals cannot be disregarded, since the municipal waste collection systems may not be able to handle a sudden increase in infectious waste. With the use of millions of PPE kits, gloves, face masks, etc. which are being discarded every day around the world, the municipal solid wastes (MSWs) handling is under immense pressure (Torkashvand et al., 2021).

Indian cities and ULBs found it difficult to manage COVID wastes along with conventional MSWs without proper infrastructural equipment. With the initial wave of COVID-19 (March 2020), the metropolitan cities like Delhi experienced severe challenges in managing MSWs including COVID wastes (Randhawa et al., 2020). With the explosion of the second wave of COVID-19 during mid-March (2021), the challenge has been amplified in a faster way than expectations.

This paper is an exploratory study capturing perceptions and practices pursued by different stakeholders, especially the ULB officials (the sanitation officers, engineers, on-site sanitation supervisors and workers) and local communities in the three sub-divisional towns of Hooghly corridor namely Chandannagar, Hooghly-Chinsurah and Serampore from June to August 2021. By drawing insights from their perspectives of COVID waste management through the deployment of qualitative research methods such as: key informant interviews (KIIs) with the ULB officials and focus group discussions (FGDs) with local communities, we finally argue that co-managing solid wastes along awareness, participation and cooperation among multiple actors is an option for urban peripheries of the global south lacking sophisticated hard infrastructures to tackle MSW, especially during the COVID scenario.

2. Review of Literature

The intensity of effectiveness and transmission of the pandemic is much higher in metropolitan towns like Kolkata as they are characterized with more dense human population and are dotted with inadequacies in SWM. Different MSWM strategies, specific challenges, and possible solutions are required for better understanding of those involved in waste management and also providing a possible management strategy during and post-COVID-19 pandemic. A set of recommendations regarding handling household medical wastes in addition to health education about disinfection and management of MSWs with scientific background is mandatory under the pandemic circumstance (Das et al., 2021). To facilitate sustainable plastic waste management under pandemic circumstances, the residents' active participation and engagement may provide higher resilience in the entire waste management chain for the developing world (You et al., 2020; Silva et al., 2020).

Considering the need of COVID waste management, the most effective disinfection technologies during the outbreak like high/low heat technologies and chemical disinfection, and PPE reusing processes, including dry heat, vaporized hydrogen peroxide, and ozone can be very useful. People also should revise their viewpoints on plastic consumption by enriching sustainable behaviors, abandoning

old habits, and adjusting to novel ones (Teymourian et al., 2021). Haque et al. (2020) have illustrated the diversification in generation of waste during the COVID-19 pandemic lockdown period in Bangladesh, where alongside the hazardous waste volume, single-use plastic items and PPE have induced a new type of PPE pollution in the land and aquatic environment. In Peru, in order to manage and handle the surging facemask, the operational efforts such as beach clean-ups carried out by citizens, along with educational workshops seems to be a plausible solution to promote cleaner environments (Torres and Torre, 2021). According to Ouhsine et al. (2020), the local inhabitants should put the preventive equipment (gloves, mask, alcohol gel, coveralls) in a special, uniform bag before throwing it in the bin to protect the garbage collectors and rag pickers. Apart from these guidelines, the ULBs should also organize systematic awareness campaigns to ensure sustainable management of COVID-19 wastes.

Emerging literature on COVID wastes within the Indian context is overtly technical and metropolitan-centric (Ganguly and Chakraborty 2021; Goswami et al., 2021; Randhawa et al., 2020; Thomas and Leon 2020). While Ganguly and Chakraborty (2021) highlight how government should implement more robust mechanisms to deal with COVID wastes from source to mouth, Goswami et al. (2021) have emphasized on capacity building of healthcare workers and waste-handlers towards safe collection, treatment, and disposal of bio-medical wastes (BMWs) as well as a well-equipped system for safe disposal in the post-COVID-19 scenario. Randhawa et al. (2020) illustrated how to involve local residents, waste pickers associations, non-governmental organizations (NGOs), and government officials to manage wastes under the pandemic scenario in Delhi.

There is dearth of literature on urban peripheries. As the second wave of the pandemic struck the peri-urban and rural areas in India, which also lag behind than their metropolitan counterparts in terms of better SWM options, we argue that there has to be alternative framings and innovative (soft) measures through which COVID wastes can be tackled. This article provides first-hand field insights from the three sub-divisional towns of the Hooghly district: Chandannagar, Hooghly-Chinsurah and Serampore to finally emphasize on how and why (co)managing COVID wastes as part of MSW through overlapping priorities and collaborations among bureaucratic, technical actors and local communities can be a viable and resilient solution.

3. Study area and Rationale

3.1 The sites

In general, these three sub-divisional towns of Hooghly district are the peri-urban towns of Kolkata metropolis. They are located along the stretch of the Hooghly Corridor. Chandannagar, Hooghly-Chinsurah and Serampore comprise our empirical frame of analysis. Chandannagar Municipal Corporation (CMC) (22°50′12″ N to 22°53′12″ N and 88°19′15″ E to 88°23′06″ E) and Hooghly-Chinsurah Municipality

(HCM) (22°52′08″ N to 22°56′19″ N and 88°22′01″ E to 88°24′15″ E) are the two adjacent class-I cities surrounded by the Bansberia Municipality in the North, the Bhadreswar Municipality in the South, the River Ganga in the East and different rural mouzas[3] in the West. The Serampore Municipality (SM) (22°43'43"N to 22°46'09"N and 88°19'01"E to 88°21'30"E) lies 20 km south of the CMC along the western bank of the River Hooghly (Fig. 2). In terms of physiography, the present study area is influenced by the lower Gangetic plain and climate-wise these areas belong to the tropical monsoonal climate (*Am*- short dry season, according to Wladimir Koppen, 1900 & 1940)[4]. On the other side, Chandannagar, Hooghly-Chinsurah and Serampore have population over one lakh i.e., 166867, 179931 and 181842 respectively as per 2011 census of India.[5] In addition to that, these three towns serve their respective rural areas as service nodal point as they are entitled as sub-divisional towns and equipped with different types of socio-economic infrastructures like health, education, market, courts etc.

3.2 Rationale of the study

COVID-19 is generally regarded as an urbanocentric disease. With its introductory wave of infection, it has created severe impacts in the different dimensions of livelihood (health, sanitation, waste generation and its management etc.) of metropolitan cities like Kolkata, Mumbai, and Chennai in India. But with the arrival of second wave of COVID-19 in early March 2021, the rate of infection has increased enormously in no time in the peri-urban areas of these metropolitan urban areas. Eventually, it has created several challenges on the existing MSWM infrastructures of each area with the additional waste generation namely the COVID wastes. Being district sub-divisions, Chandannagar, Hooghly-Chinsurah and Serampore towns offer socio-economic opportunities to attract a considerable chunk of (floating) population from surrounding rural areas. As a result of which, there is a huge accumulation of conventional solid wastes in the study area. Due to the daily influx of floating population in the post initial wave of the COVID-19 pandemic (since late November, 2020), these three cities have experienced an upsurge (Table. 1) in case of per capita waste generation as well as in overall solid waste generation, also determining an increase in COVID wastes, especially during the outbreak of the third wave.

[3] *Mouza* or *mauza* is a Bengali word used in Bangladesh and West Bengal to imply an administrative district corresponding to a specific land area within which there may be one or more settlements.

[4] https://www.nationalgeographic.org/encyclopedia/koppen-climate-classification-system

[5] https://censusindia.gov.in/2011census/dchb/DCHB_A/19/1912_PART_A_DCHB_HUGLI.pdf (pp. 45)

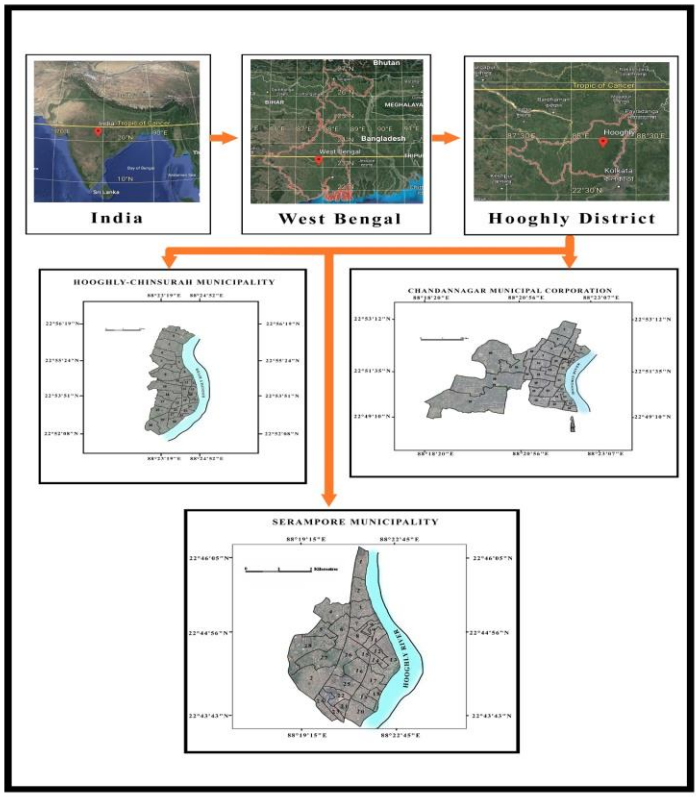
Table. 1: Changing Trends of Waste Generation in the Study Area

Towns	Waste generation in a municipality (MT-Metric Tons/day)			Per capita waste generation (gms/day)		
	1993	2011	2020	1993	2011	2020
Hooghly-Chinsurah	15.36	80.21	85.10	145.23	470.6	472.40
Chandannagar	14.96	68.34	76.53	142.35	419.32	458.62
Serampore	9.36	50.00	90.00	110.23	277.85	494.93

Source: Compiled from interviews conducted with sanitation officers (HCM, CMC and SM) (April-May, 2021)

Inadequate financial arrangements and inappropriate technical apparatuses i.e., the "hard interventions" are major impediments for ULBs to run successful SWM program in the study area under the global pandemic scenario. There arises an important question as to how with limited infrastructural equipment and funding, this extra load of waste can be negotiated? It is within this context, that capacitating local communities' perception and involving them in MSWM system in the COVID-19 pandemic situation to assist ULBs can be a significant intervention. In order to capacitate and activate communities, first and foremost step will be to trace the perception and performance stature of the local community stakeholders regarding the SWM in the pandemic scenario through extensive empirical research process. These peri-urban sub-divisional towns lack hard infrastructural resources (lack of proper dumping ground, lack of transport vehicles) to tackle the COVID wastes. Here, the "soft interventions" like the perceptions and performance tracking of the local community members and perspectives of ULB officials can be carried forward for the alternative arrangements of the COVID waste. In this article, we have conducted KIIs with the ULB officials and FGDs with local inhabitants to map their perception and performance levels. We also tried to understand the COVID waste management challenge and opportunity scenario as laid out by the interviewed. We finally argue that these qualitative insights can make way to develop more robust quantitative design through which awareness-induced and cost-effective (co) management options can be mapped and implemented.

Fig. 2: The Study Area



Source: Author (Das), with assistance from Google Earth

4. Lessons from the field

The first part of the primary study that was conducted places key insights manifested from interviews conducted with the officials of the ULBs and the second part is a compilation of reflections from local communities or residents of the study area.

4.1. Understandings of ULB officials

CMC

CMC officials stated that in order to cope with COVID wastes along with MSWM, they undertook extensive efforts like complete ban on the plastics and instead mandated carrying of cotton carry bags. They also put in place a fine of minimum ₹500 on the vendors and consumers found using the plastic bags.

According to Mr. Suman Das (chief sanitation officer of CMC) (July, 2021),

"Lockdown has intensified online shopping and its related wastes like cardboards, plastic wrappings have led to an upsurge of plastic accumulation." While discussing segregation at the source, he further

> mentioned, *"We have already started to distribute two separate bins (from January 2021) to every household of the city. As, we are expecting that the local community stakeholders' contributions will be helpful in this 'segregation at the source' mission. 'Mission Nirmal Bangla' (Mission Clean Bengal) scheme for the biodegradable (green color bin) and non-biodegradable wastes (blue color bin) segregation."*

He further added,

> "*We are trying to ban all the micro plastic bags by imposing finest of minimum ₹500 for both the vendors and consumers. Instead of micro plastics, we are encouraging the local community members to use bags made of cotton and jute for daily purchase of vegetables, flesh type foods and other type of stuffs from the market. Apart from that, we have adopted newer techniques like bio-mining[6] to compose the bio-degradable wastes along with the plastic wastes."*

According to Ram Chakraborty (previous mayor-in-charge) (May 2021),

"We are installing a new machine (Fig. 3b) which will segregate biodegradable, non-biodegradable and COVID wastes (especially facemasks, sanitizer bottles, and gloves) in our Kolupukur Dhar dumping ground. The non-biodegradable plastic wastes will be taken care of by the Ambuja cement company. On the other side, we are now using the bio-mining process[7] (spreading earthworms to decompose the biodegradable wastes early). We are expecting that with this process, within 2 to 3 years, 80% of the biodegradable wastes will be decomposed. We will also able to manage COVID wastes by reducing the biodegradable wastes. We will be able to dump and incinerate the wastes in future."

He also stated that *"we are trying to collaborate with neighboring ULBs to find out an alternative disposal ground to tackle the COVID wastes."*

[6] Bio-mining is the process of using micro-organisms (microbes) to extract metals of economic interest from rock ores or mine waste.

3(a) **3(b)**

Fig. 3(a): Involvement of women in waste transportation and

Fig. 3(b) Installation of new machine for COVID waste and municipal wastes

Source: Author (Das), field visit in June 2021

While asking about the local community stakeholders' participation issue, the previous mayor of CMC also added, *"We have recruited the local women (Fig. 3a) in their respective residential area based on their respective educational qualifications in order to collect wastes from the households to the community bins across 33 wards. Each ward has five to six women for that collection of waste process. Their monthly salary is ₹3000."*

HCM

HCM area is the district headquarters of the Hooghly district. Having that socio-economic status, this area experiences a significant amount of population pressure on a daily basis, which has ultimately impacted the waste generation and management scenario. While discussing about the COVID waste management strategies with Himanshu Chakraborty (sanitation officer of HCM), some issues become very clear that they are not satisfied about the local community members' practice mechanisms under this global pandemic scenario.

According to Chakraborty (July 2021),

> *"People throw the facemasks, sanitizer bottles, gloves and other COVID wastes along the roads despite various awareness advertisements across the town. We are providing two separate bins to segregate biodegradable and non-biodegradable wastes, but they use those bins as their domestic water containing bins. When we question them on such practice, they response elicits lack of time to segregate the wastes."*

In case of disposal of wastes, he also added,

> *"Just like the CMC, we have deployed the bio-mining process to decompose and reduce the biodegradable wastes, to create more spaces for the COVID*

> *waste management. The SIGMA group (2020) has already surveyed our dumping ground near Sukantanagor (Rabindranagar bazar area) and suggested for a newer dumping site along with the Sukantanagor one for the COVID waste management."*

In order to reduce the impact of COVID waste and its management loopholes, the HCM sanitation officer pointed out,

> "*We are trying to collaborate with the neighboring municipalities like Bansberia Municipality and CMC for a common waste dumping ground and treatment plant" as the HCM officials think that the pressure and challenge of COVID waste management will escalate in coming years."*

From these reflections, it is evident that HCM is in the preparatory stage to manage COVID wastes along with conventional solid wastes. The ULB is looking forward to a better dumping and recycling process to lift the urban environmental status of the town.

SM

The Serampore town is recognized as the most eco-friendly town of the Hooghly district. However, with the arrival of the COVID-19 pandemic, the situation is grim so far as SWM in SM is concerned. The introduction of COVID wastes has burdened MSWM practices of SM.

While pursuing KII with the chief sanitation officer of SM, Anuj Banerjee (July, 2021), he stated that

> "*We are now trying to segregate the conventional MSW from the COVID wastes. We have already launched some campaigns to advertise the side effects of COVID wastes across the town during the early August, 2020. Most of the people have responded in a sound way. But in some areas like Dakhin Rajyadharpur, Mahesh, Sideshsoritola, people are still mixing all the solid wastes with the COVID wastes. We have already provided two separate bins for the biodegradable and non-biodegradable wastes under 'Mission Nirmal Bangla Scheme'. But people are still not aware about the dangers from COVID waste."*

On the dumping ground scenario, he mentioned,

> *"We have two dumping grounds. One is our own which is located along the Rayland circular road (south Serampore, Mahesh Colony along the Eastern railway track) and the other one is collaborated with the Uttarpara-Kotrong, Konnagore, Rishra, Baidyabati and Champdani Municipality near*

Rishra station. We are planning to ban the plastics just like other neighboring ULBs."

From this interview, it can be interpreted that the Serampore municipal authority is very keen to segregate and dumping the wastes in a sustainable way. The scheme of collaboration with other municipalities is directed by the Kolkata Metropolitan Development Authority (KMDA). SM is prioritizing the COVID waste segregation at the source and recycling of the same in a much healthier and safer way.

4.2. Viewpoints of local communities

CMC

Chandannagar is very popular for its cultural and colonial history. The COVID-19 pandemic has struck its local tourism and economic growth. Moreover, KII with one of the ULB officials confirmed that while during pre-pandemic times the daily per capita waste generation was about 419.32 gms/day, recently, i.e., since mid-2020, it has increased to 458.62 gms/day. This shows that the uses of different waste producing materials have risen. Local residents have a huge role to play from waste emitters and disposers to coping actors and adaptive managers. Thus, their key perspectives and practice mechanisms become essential and must be incorporated into the COVID waste management framework.

In general, people are dissatisfied with the performance of the CMC. Regarding waste segregation at the source, according to some local inhabitants (Ward no. 14 near Hatkhola Monosatola), *"We segregate the biodegradable and non-biodegradable wastes into different bins and also the COVID wastes in a plastic bag. But, at the time of collection, the waste collectors mix all the type of wastes and put them into their respective waste bins for transportation. The waste collectors often argue that they do not have enough time to segregate the wastes."* Residents further added that *"We are not satisfied even about the cleaning process of the community bins. Those bins are cleared by the municipal corporation in every fortnight ultimately creating severe odor and pollution. We have frequently complained about the situation to the local ward coordinators (previously ward counselors), but do not receive any proper response."*

Inhabitants from ward no. 2 and 3 (Fig. 4a) added, *"When we complain about the waste collectors' non-cooperative behaviors to the on-site supervisors, they use to say that it will be taken care of. But the reality remains the same. Often the masks, gloves sanitizer bottles are left in the community bins for over a week. But the corporation does not take care about it. They are very happy about the inclusion of local women in the waste management practice. Plenty of people think that this is very good move by the corporation to provide some empowerment to some needy families. In future, this move should be encouraged more."*

The CMC officials appeared to be very confident about their ground planning to cope with swelling COVID wastes. But, the above mentioned FGD results of the CMC localities are clearly depicting the loopholes of the CMC's existing COVID waste management system, when it comes to execution. The frustration among the community members across the CMC town about the non- co-operative behaviors of the waste handlers and collectors during the lockdown period demonstrated the persisting lack of knowledge about the danger of waste mixing among the waste handlers during door-to-door collection. Apart from that, it was underscored that with the inclusion of women waste collectors since January-2021, the community members have found it easier to communicate while handing the wastes over to them for further transportation.

4(a)

4(b)

4(c)

Fig. 4 (a), (b) and (c): FGDs across three different towns

Source: Author (Das), field visit in June-July 2021

HCM

As per the on-site supervisor (Almas Hussain),

> *"There is a certain amount of unrest among the local residents near the HCM's dumping yard (close to the Sukantanagor area), as during the transportation of the wastes especially the COVID wastes (facemasks, gloves) and other municipal wastes (Fig. 5)."* According to one of the local inhabitants, *"While the tractors use to litter everywhere outside the main dumping yard. We have already written some complaints about the littering across the roads to the municipality, but they never came here to see the conditions."*

Fig. 5: Littering during waste transportation

Source: Author (Das), field visit in July 2021

While discussing about the frequency of the waste collection (near Tolafotok area), communities argued that

> *"The waste collectors come to collect the wastes twice a week. Sometimes, once a week they come. But before the pandemic, every day the municipal waste collectors came to collect the wastes. During the pandemic, we use to carry and dump the wastes in the local community bins and often the bins are over saturated with the wastes. The pandemic scenario reduces the frequency of the waste collection."* According to them, *"The municipal authority often dumps the wastes along the Ganga River (Fig. 6a) and Kumorpara (Fig. 6b) area mixed with sanitizer bottles, facemasks etc. The wastes have been dumping since December 2020 along the banks of Hooghly River to fill the lands there for municipality future development projects like children's park."*

6 (a)

6 (b)

Fig. 6(a): Disposal of wastes along the Ganga River

Fig. 6(b): Unhealthy deposition of waste in Chinsurah Kumorpara area

Source: Author (Das), field visit in June-July 2021

It can be noticed that the local community stakeholders are not satisfied with the frequency of waste collection during the pandemic scenario, and they are also appealing about the non-landfilling along the Ganga River which ultimately creates lots of problem for them like odor, unhealthy living conditions.

SM

FGDs in the Serampore reveal varying levels of satisfaction among local communities about the ULB's role in SWM. People from the Sideshsoritola remain satisfied. To them, *"The municipal authority has been provided couple of waste bins since December 2020 to promote the waste segregation at the source and we are maintaining the same across our areas. Previously, before pandemic, we used to dump all the wastes in our households within a particular bucket and throw them into the community waste bins provided in our locality."*

FGDs near the south Rajyadharpur area (in front of the Serampore ESI hospital) showed one of the severe drawbacks of the city governing authority. According to a mobile shop owner, *"Due to extensive dumping of wastes from the Serampore ESI hospital (especially the COVID wastes) (Fig. 7a and 7b), one blacksmith person died due to extreme odor in November, 2020. Another threat is often found due to extreme and irregular cleaning of community bins, arrival of snakes. We often use carbolic acid to stay away from the snakes. The municipal authority clears these areas once in every fortnight and this ultimately creates a bad environment for marketing. Personally, I have complained several times but they don't response in a proper way."*

From the above dialogues of different community stakeholders across the SM areas, it is very much recognizable that they are very much exasperated with the ongoing community bin clearance routines of the local ULB authority. Their appeals for immediate actions against such practices, especially during the pandemic, needs urgent attention, else it may cause severe disruption of the town's environmental and health scenario.

7 (a)

7 (b)

Fig. 7(a) PPE kits (Mark-1 with red color) and Surgical Facemasks (Marking 2 with red color) with other municipal solid wastes in front of ESI hospital Serampore Rajyadharpur

Fig. 7(b) KII with a mobile shop owner (Raju Shrivastava) in Serampore Rajyadharpur area (June-July, 2021)

Source: Author (Das), field visit in June-July 2021

The overall priorities of each town's community stakeholders have been tabulated in to find out the area of improvement in COVID waste management.

Along with the priorities of ULB officials, the community stakeholders' priorities can be incorporated to frame a suitable and sustainable COVID waste management framework for these three sub-divisional towns of Hooghly district and make SWM truly participatory.

5. Conclusion

Our qualitative reflections from the three towns demonstrate that each ULB has its own specific COVID waste story. For CMC, the most prioritized element is the segregation of COVID wastes from the conventional municipal solid wastes; while for HCM the key concern is less frequent waste collection during the pandemic scenario, which ideally, should be regular in nature. In case of SM, lack of proper and irregular community bin clearance is the pivotal concern in this crunch.

The CMC governing body has planned to come up with an awareness mobilization program by reaching out to every locality so that people become conscious of hazards and dangers relating to COVID wastes. The CMC authority has deployed bio-mining processes to find out more places within their stipulated dumping yard for the treatment of COVID wastes. Adding to that, in order to create a common dumping yard policy, they are also trying to collaborate with HCM and Bansberia municipality. Just like the CMC authority, HCM is also implementing the bio-mining process for the better space availability of COVID waste management and trying to collaborate with CMC for better waste management policy under COVID pandemic scenario. On the other hand, the SM is already involved in the common dumping yard policy and it is recommended that rest of the two towns take some inputs on that. SM authority has also prioritized regular sanitization and clearance of the local community bins to stop the unwanted transmission of COVID-19 virus.

The community members of the three different towns were not satisfied enough with the planning and execution of their respective ULB authorities. Their main concern was the mixing of wastes and lack of regular local waste bin clearance in this crunch time. As per their suggestions, ULBs should invest and strategize in separating wastes through uses of differently-marked bins. Three differently colored big waste bins should be placed in every ward for smooth waste collection and disposal activities. The bio-degradable and non-biodegradable wastes should be taken care of by the ULBs and dedicated staff within or beyond ULBs should be trained to tackle COVID wastes.

We argue that qualitative or descriptive insights from different stakeholders are important to capture the ground scenario in small towns within the COVID context. These remain important not only to understand the conflicting perspectives among stakeholders but also map cross-cutting, converging possibilities through which solid wastes can be (co)managed along soft measures

such as awareness, participation, involvement and engagement in tackling COVID-induced solid wastes.

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Conflict of interest

We the authors hereby declare that we have followed the accepted principles of ethics of study. We also confirm that there is no way our manuscript is in possible conflict with the ethical standards required by the Journal.

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Annexure

Open-ended questions used for Key Informant Interviews (KIIs)

1. Name and affiliation of the Key Informant, affiliated to_____Urban Local Body (ULB):

3. What are the existing SWM practices in this particular ULB under your jurisdiction?

4. Do you see (dis)similarities in the generation of solid wastes during the pre-COVID-19 and COVID-19 scenarios?

5. Has this difference impacted upon the SWM practice system here?

5. What are the roles and responsibilities being played by multiple stakeholders including ULB personnel and local communities in tackling the solid waste situation during the pandemic?

6. Kindly elaborate on people's perceptions, performance and practices.

7. Can you kindly share if the ULB is sincerely planning effective strategies to more effectively cope with the COVID situation, for example more efficient mechanisms to segregate the COVID-19 wastes from conventional municipal solid wastes?

8. What would be your final comment on how ULB and community awareness and participation can be activated in collaboratively planning and executing appropriate SWM practices.

Open-ended questions used for Focus Group Discussions (FGDs)

1. Number of FGD members:

2. Location and Municipality:

3. Do you notice any significant change in the generation of solid wastes during the pre-COVID-19 and COVID-19 scenarios, particularly in your locality/ULB?

4. Are you satisfied with the current SWM practices prevalent in your area?

5. What are your reflections on the performance of ULBs in terms of dealing with the present SWM scenario? What are the major complaints and notes of appreciation?

6. What is the role played by local community to deal with the situation?

7. What are your responses relating how community awareness and participation can be activated in collaboratively planning and executing appropriate SWM practices in collaboration with the ULB officials and actors?

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Policy Perspectives

What Can Really Explain the Inter-state Variations in COVID-19 Outcomes in India?

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Abstract

The study investigates into the explanatory factors for the variation in COVID-19 infections and deaths reported in Indian states as on March 31, 2021. The analysis considered the following state-wise data: proportion of people living in cities with population density higher than 5,000 persons per sq. km, per capita public health expenditure, health infrastructure per thousand population, per capita NSDP, and proportion of aged (above 60) people. As regards COVID-19 infections, the proportion of people living in densely populated areas (above 5,000 persons per sq. km), per capita NSDP and proportion of aged people explained the variation across states. As regards the deaths due to COVID-19, in addition to these three factors, per capita public health infrastructure was found to be a contributing factor, with its impact on death being negative. The curious situation of income increasing COVID-19 transmission and death could be probably explained by the considerable proportion of the people in some of the high-income states living in congested slums under extreme poverty with poor access to basic infrastructure, and the high mobility and exposure of some of these states to domestic and international travel footprint and large migrant population, all resulting in increased risk.

Keywords: COVID-19 Infections; COVID-19 Deaths; Net State Domestic Product; Densely Populated Area; Health Infrastructure; Public Health Expenditure; Population Density

While the COVID-19 Pandemic has taken a heavy toll on the world economy and public health, what has caught the real attention of the epidemiologists and researchers is the vast variation in the incidence of the diseases and more importantly, the dramatic variation in the deaths associated with the disease for the same size of the population. What has surprised most is the phenomenon that is taking a heavy toll on the life of people in the developed countries such as the US, UK, France, Germany, Spain and Italy, which are generally known for effective

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governance, robust public health system, high literacy and good public awareness about the diseases. Not only were the incidence of COVID-19 (per thousand people) high, but the number of reported deaths per million population were also high in these countries.

Since the pandemic started in December 2019, several studies have been undertaken worldwide to identify the factors that led to spread of the COVID-19 infections and mortality in different countries and regions. Most of such studies either used statistical (regression) analysis or machine learning tools to predict the dynamics of the spread of COVID infections and mortality rates. The main factors that were explored include demographic indicators (population density, aging population, per capita income, etc.), environmental variables (temperature, humidity, UV radiations, etc.), and healthcare and infrastructure facilities.

In this article, we investigate into the various factors that explain the variation in the incidence of COVID-19 infections and deaths associated with the disease across Indian states and seek to find scientific explanation for the same, using the knowledge available in the field from scientific research. An extensive review of the research studies done internationally (including that in India) on COVID-19 infections and death was done to identify the most dominant demographic, socio-economic and public health infrastructure related factors that were found by these studies to be the influencing factors and were used to inform the current study vis-à-vis selection of variables for the analysis.

Review of International Research on COVID-19 Transmission

Irrespective of the regions, many studies found population density as the major socio-economic factor influencing the spread of COVID-19 infections. In the US, states with high population density and testing exhibited consistently high infections and deaths (Roy and Ghosh, 2020). Further, the spread was higher in the vulnerable groups that include African Americans, Hispanic-Latina, and older adults (Wong and Lee, 2020; Jin *et al.*, 2021). In Algeria of north Africa, a strong correlation was established between the population density and the number of COVID-19 infections, i.e., the spread of the infections was higher in cities with high population density (Kadi and Khelfaoui, 2020). Further, in the city of São Paulo, epicentre of COVID-19 in Brazil, cumulative confirmed cases were found to be positively correlated with population density, and negatively correlated with isolation rate, indicating that the physical distancing has been effective in reducing the viral transmission (Nakada and Urban, 2020). However, in the European Union, irrespective of the population density, countries with higher proportion of the population living in urban areas experienced higher peak of COVID-19 deaths (Jablonska *et al.*, 2021).

Some research studies also looked at the role of environmental variables in the spread of COVID-19 infections. Based on the data of 188 countries, air pollution (% CO_2 in the air) along with the population density was found to be main factor driving the increased viral spread. Further, the temperature or air pressure in these

countries did not have the same effects as pollution or population (Aabed and Lashin, 2021). In Brazil, an inverse relationship was observed between the COVID-19 confirmed cases and temperature and also with the UV radiation, suggesting that the sunlight might be effective in reducing the infectivity of the virus (Nakada and Urban, 2020).

Another set of analysis using global data set found that regions with low and high annual average temperature, both favour the transmission and incidence of the disease with different intensities (Magd *et al.*, 2020). Nevertheless, in China, UK, Germany and Japan, the spread and decay stages of the COVID-19 pandemic were directly correlated with absolute humidity, temperature, and population density (Diao *et al.*, 2021). Velasco et al. (2021) found that the temperature of 14.5°C is in the favourable range for the growth of the virus. In Russia, the seasonality of climate also had an impact on the COVID-19 transmission and infection. In the humid continental region, seasonal variation in temperature, which is the difference between the annual maximum and annual minimum temperature was the primary influencing variable for the COVID-19 transmission, with increased difference resulting in greater transmission of the virus. In the sub-artic region, the mean temperature diurnal range, which is the difference between average daily maximum and average daily minimum temperature was the primary influencing factor. Higher difference resulted in higher transmission of the disease (Pramanik et al., 2020). Thus, unlike population density, environmental factors had varying impacts in different climatic zones.

Some studies also found that the hardest hit countries either had an aging population (Gardner *et al.*, 2020; Upadhyaya et al., 2020) or underdeveloped healthcare systems (Tanne et al., 2020). The importance of healthcare infrastructure was obvious in Thailand where large scale infections were controlled by combination of a good healthcare system and regulation on the tourism activities (Tantrakarnapa *et al.*, 2020). Further, the per capita income had a negative and statistically significant effect on COVID-19 death rate globally (Upadhyaya et al., 2020). For instance, in Mexico, high poverty and income inequality aggravated the spread of the pandemic (Benita and Gasca-Sanchez, 2020). In the European Union, lower reduction in mobility at the beginning of the pandemic and countries having more infected people when closing borders (lockdown) experienced higher mortality rate (Jablonska *et al.*, 2021). High mobility (either through air or road) was also identified as one of the factors leading to spread of COVID-19 infections in the US (Roy and Ghosh, 2020) and Brazil (Nakada and Urban, 2021).

A recent study in the UK carried out by the London School of Hygiene and Tropical Medicine after the second wave found higher risks for testing positive and subsequent poor outcomes amongst minority ethnic groups. When compared with wave 1, the relative risk for testing positive, hospitalisation, ICU admission, and death were smaller in pandemic wave 2 for all minority ethnic communities compared to white people, with the exception of South Asian groups. South Asian groups remained at higher risk for testing positive, with relative risks for

hospitalisation, ICU admission, and death, which were greater in magnitude compared to the first wave. Despite the improvements seen in most minority ethnic groups in the second wave compared to the first, the disparity widened among South Asian groups (Mathur *et al.*, 2021).

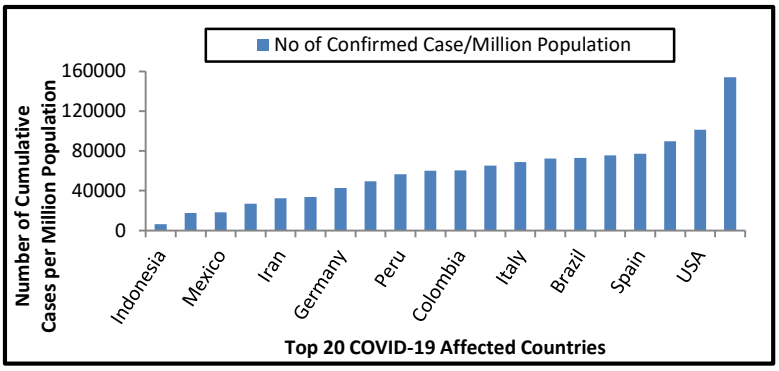
After accounting for age and sex, social deprivation was the biggest potential explanatory variable for disparities in all minority ethnic groups except South Asian. In South Asian groups, health factors (e.g., body mass index, blood pressure, underlying health conditions) played the biggest role in explaining excess risks for all outcomes. Household size was an important explanatory variable for the differences in COVID-19 mortality in South Asian groups.

Thus, studies globally suggest the influence of the following factors on the spread of COVID-19 infections and COVID-19 related deaths, viz., demography, climate, economy, social diversity, mobility, and health infrastructure. However, the factors identified and their natures of influence were different for different countries.

Studies on COVID-19 Transmission in India

During the first wave, India had one of the largest numbers of COVID-19 infections (15 million), which is a little more than 1% of the population. The number of COVID-19 deaths stood at 1,50,000 people, which is nearly 1% of the total reported cases. Even among the 20 worst affected countries in terms of the number of reported cases as on 16th May 2021 when the second lethal wave was ongoing in India, it had the second lowest number of confirmed cumulative cases per million population (Figure 1). Though as a proportion of the total population, these numbers are still very small, the sharp variation in the reported cases of COVID-19 infection and deaths across Indian states had created an equal amount of curiosity among researchers working in the field from the country. Several theories were postulated by medical professionals and public intellectuals over the past few months on the factors that could probably explain the sharp variation in the COVID-19 cases and COVID-19 deaths between developed and developing countries and between regions within India. In both the cases, one frequent explanation that was provided was in the high discrepancy in reporting of cases and deaths. It was argued that the reporting system is very accurate in the developed countries, and not good in developing countries like India.

Figure 1: Confirmed cumulative cases of COVID-19 in the 20 most- affected countries as of 16 May 2021



(Source: Authors' own analysis based on data accessed from the world-o-meter)

A recent paper by Balakrishnan and Namboothiri (2021) examined the factors responsible for the variation in COVID-19 cases in India, by considering the Case Fatality Ratio (CFR), using multivariate analysis. They revised the CFR estimates available from the state health departments and ran regressions considering the following factors: 1) population density; 2) the public health expenditure as a share of the state Gross Domestic Product (GDP); 3) public health infrastructure; and 4) per capita income. They concluded that the case fatality ratio is inversely proportional to the proportion of the government expenditure on health. The population density was also considered as one of the social determinants influencing the spread of COVID-19 pandemic in India in the studies by Arif and Sengupta (2020) and Pandey *et al.* (2021).

The analysis by Balakrishnan and Namboothiri (2021), however, suffered from the following problems on the conceptual and practical fronts. First of all, they have treated 'health expenditure (HE) as a share of the GDP' as a variable to represent the public health expenditure by state governments. This is conceptually and theoretically incorrect. It is not the proportion of the GDP spent on public health which matters, but the actual health expenditure per capita (Rs/capita) incurred by the state, the reason being that there is wide variation in the GDP across states and even the per capita GDP. Therefore, it is quite possible for a state with very high per capita Net State Domestic Product (NSDP) spending a small fraction of its GDP for health, but the actual expenditure could be quite sizable.

Secondly, there are other major factors which probably could be driving the COVID-19 cases and CFR, an important one being the number of poor people (and NOT per capita income). Again, it is not the average population density *per se* (also included in the analysis by Arif and Sengupta, 2020 and Pandey *et al.*, 2021)., but the proportion of the population living in very densely populated areas (like densely populated cities) that really matters. For instance, in Mumbai, the population density is above 35,000 persons per sq. km, and in its slums, it can be anywhere near 200,000 per sq. km. At the same time, the population density of major states (excluding the city state of Delhi) varies from 218 (for Chhattisgarh) to 1,122 (for West Bengal) people per sq. km, which does not matter when it comes to

transmission of a disease like COVID-19. But it does matter when it crosses a certain threshold, say 5 to 10,000 persons per sq. km. What is most important is even in less densely populated states, there are cities that have very high population density. Another factor could be the proportion of people living below poverty and without basic amenities like in slums. Once these factors are considered, the results would be different.

Another important issue is the relevance of case fatality ratio (CFR). Case fatality ratio refers to number of deaths per 100 reported cases of infection. That being so, the actual number of reported cases of infection per 1,000 population varies drastically amongst the states. Therefore, the use of this indicator (CFR) would hide the gravity of the problem in situations where the case load is very high (like in Kerala where CFR is only 0.40) and exaggerate the situation in states like Punjab where the CFR is very high (3.2). But the deaths per 1,000 people in Kerala is 0.12, against 0.19 in Punjab, indicating a minor difference. In that case, what really needs to be considered is the number of deaths per 1,000 of total population. So, the studies that try to identify the determinants of virus transmission need to look at the rate of infection and deaths in relation to the total population.

Data and Approach for the Study

For undertaking the analysis, we collected the data on COVID-19 cases in Indian states, from 2020 when the first case was reported, till early March 2021. Before proceeding with the analysis, we assumed that the data are reliable and accurate enough to show the variation in cases across the states. This assumption doesn't mean that the statistics are correct. It only means that even if there are significant reporting errors or manipulations, that applies to all states more or less uniformly. However, we discarded the data for the state of Bihar, as a close examination of the data during the analysis stage revealed them to be an 'outlier', probably due to serious problems with reporting of cases from that state.

State level data used for various analysis are as follows: 1) population; 2) COVID-19 infections and COVID-19 deaths; 3) Net State Domestic Product (NSDP), 4) average human development index (HDI), 5) proportion of people living in poverty; 6) public health expenditure for nine consecutive years; 7) public and private health infrastructure (no. of hospital beds); 8) number of persons living in cities with population density exceeding 5,000 per sq. km; and 9) total population above the age of 60. From these, the values of following variables were derived: 1) no. of COVID-19 infections per 1000 people; 2) number of COVID-19 deaths per 1,000 people; 3) CFR; 4) per capita NSDP; 5) proportion of people living in areas with population density higher than 5000 per sq. km; 6) proportion of people above the age of 60; 7) average annual per capita public health expenditure; and, 8) health infrastructure per 1000 people. All the variables are described in Table 1 and their estimated values are presented in Table 2.

Table 1: Description of study variables

S. No.	Variable	Description
1	Number of COVID-19 infections per 1000 people	Ratio of the total number of reported cases of COVID-19 and the total population in 000' of the respective state
2	Number of COVID-19 deaths per 1,000 people	Ratio of the total number of reported cases of COVID-19 related deaths and the total population in 000' of the respective state
3	Case Fatality Ratio (CFR)	Ratio of the total number of COVID-19 related deaths and the total number of COVID-19 reported cases in 00' in the respective state
4	Per capita Net State Domestic Product (NSDP)	Adjusted (to constant prices) NSDP divided by the total population of the respective state
5	Proportion of people living in areas with population density higher than 5000 per sq. km	Ratio of the total number of people residing in areas (cities/towns) having a population density higher than 5000 per sq. km and the total population of the respective state
6	Proportion of people above the age of 60	Ratio of the total number of people above the age of 60 and the total population of the respective state
7	Average annual per capita public health expenditure	Ratio of the average (of nine years) annual health expenditure and the total population of the respective state
8	Health infrastructure per 1000 people	Total number of beds in public and private hospitals divided by population in 000' of the respective state

Table 2: Population density, NSDP per capita, health expenditure per capita, health infrastructure, HDI, poverty rates, COVID-19 infection and COVID-19 death rates in different states

State	Population	Population Density	Average Public Health Expenditure (Rs)	Average Public Health Expenditure per Capita	Poverty Rate (2011-12)	Per Capita NSDP Capita	HDI	COVID-19 Deaths / 1000 People	CFR (%)	COVID-19 Cases/ 1000 People	Proportion of Population living in Density Above 5000 /sq. km	PHI per 1000	Private Health Infrastructure per 1000 People	Health Infrastructure per 1000 People	Fraction of Population above the age of 60
Andhra Pradesh	53903393	331	52371369	972	9.200	107241.0	0.650	0.133	0.805	16.513	0.019	1.115	1.115	2.230	0.090
Arunachal Pradesh	1570458	19	5154949	3282	34.670	93191.0	0.660	0.036	0.333	10.722	0.000	1.531	0.140	1.671	0.041
Assam	35607039	454	27532185	773	31.980	60695.0	0.614	0.031	0.502	6.111	0.000	0.481	0.198	0.679	0.058
Chhattisgarh	29436231	218	17893450	608	39.930	69500.0	0.613	0.131	1.228	10.634	0.000	0.320	0.272	0.592	0.068
Delhi	18710922	12617	35509329	1898	9.910	269505.0	0.746	0.583	1.706	34.188	1.000	1.303	0.806	2.109	0.061
Goa	1586250	428	5555658	3502	5.090	337745.0	0.761	0.502	1.445	34.719	0.000	1.899	0.991	2.890	0.103
Gujarat	63872399	325	54942007	860	16.630	153495.0	0.672	0.069	1.629	4.239	0.213	0.316	0.700	1.015	0.075
Haryana	28204692	638	23757545	842	11.160	169409.0	0.708	0.108	1.126	9.613	0.050	0.399	0.883	1.281	0.078
Himachal Pradesh	7451955	134	13657844	1833	8.060	139469.0	0.725	0.134	1.694	7.891	0.000	1.664	0.489	2.152	0.094
Jammu and Kashmir	13606320	61	18999975	1396	10.350	65178.0	0.688	0.144	1.547	9.304	0.000	0.536	0.052	0.588	0.068
Jharkhand	38593948	484	18221684	472	36.960	54982.0	0.599	0.028	0.909	3.116	0.028	0.279	0.407	0.687	0.061
Karnataka	67562686	352	48945556	724	20.910	148970.0	0.682	0.183	1.296	14.091	0.138	1.032	2.848	3.879	0.086
Kerala	35699443	919	39592828	1109	7.050	148078.0	0.779	0.118	0.397	29.812	0.017	1.065	1.715	2.780	0.118
Maharashtra	123144223	400	81530194	662	17.350	147450.0	0.696	0.424	2.408	17.616	0.243	0.418	1.464	1.882	0.090
Manipur	3091545	138	4568596	1478	36.890	51180.0	0.696	0.121	1.274	9.472	0.000	0.462	0.117	0.579	0.065
Meghalaya	3366710	150	5036290	1496	11.870	62458.0	0.656	0.044	1.060	4.148	0.000	1.324	0.234	1.558	0.041
Mizoram	1239244	59	3686706	2975	20.400	129609.0	0.705	0.008	0.226	3.572	0.000	1.611	0.403	2.014	0.056
Madhya Pradesh	85358965	277	44018258	516	31.650	56498.0	0.606	0.045	1.473	3.074	0.021	0.364	0.396	0.761	0.067
Nagaland	2249695	136	4285812	1905	18.880	73276.0	0.679	0.040	0.746	5.423	0.000	0.836	0.303	1.138	0.046
Odisha	46356334	298	29545457	637	32.590	75191.0	0.606	0.041	0.568	7.277	0.000	0.399	0.154	0.553	0.086
Punjab	30141373	598	24289117	806	8.260	115882.0	0.723	0.194	3.193	6.089	0.120	0.595	1.429	2.024	0.095
Rajasthan	81032689	237	58948886	727	14.710	78570.0	0.629	0.034	0.869	3.956	0.044	0.581	0.569	1.150	0.063
Sikkim	690251	97	2450316	3550	8.190	242002.0	0.716	0.196	2.196	8.905	0.000	2.260	0.568	2.828	0.059
Tamil Nadu	77841267	598.5	66853654	859	11.280	142941.0	0.708	0.161	1.467	10.951	0.094	0.996	1.000	1.996	0.097
Telangana	38510982	344	23718971	616	8.800	143618.0	0.669	0.042	0.546	7.771	0.175	0.545	2.050	2.595	0.090
Tripura	4169794	398	5235258	1256	14.050	82632.0	0.658	0.094	1.170	8.015	0.000	1.062	0.057	1.119	0.070
Uttar Pradesh	237882725	72	114920365	483	29.430	43670.0	0.596	0.037	1.446	2.538	0.040	0.321	0.862	1.183	0.065
Uttarakhand	11250858	210	12501405	1111	11.260	155151.0	0.684	0.150	1.743	8.629	0.000	0.757	1.363	2.119	0.080
West Bengal	99609303	1122	58718955	589	19.980	67300.0	0.641	0.103	1.784	5.777	0.061	0.789	0.351	1.140	0.078

Sources: Population and related variables, and public health expenditure is based on data accessed from the Ministry of Health and Family Welfare, Government of India; Poverty rates are from the RBI handbook of statistics on Indian economy 2020-21; Per capita NSDP is based on the 2018-19 data from the Ministry of Statistics and Programme Implementation; HDI is based on Global Data Lab 2019 figures of Sub-national HDI; COVID-19 infections and death related estimates are from mygov.in; and Health infrastructure estimates based on Kapoor et al., 2020.

The variables described in Table 1 were used for developing two multivariate regression models to explain the variation in COVID-19 infections (Model 1) and COVID-19 related deaths (Model 2) across different Indian states. All the chosen independent variables for running the multivariate regression analysis were mutually exclusive. Overall, three independent variables were chosen to explain the variation in COVID-19 infections and five were chosen to explain variation in COVID-19 related deaths across different Indian states. The analysis is presented in the subsequent sections.

What Explains the Variation in COVID-19 Infections Across Indian States?

Following were the hypothesis to begin with. As public health research has shown population density would have significant influence on spread of an infection like COVID-19. However, as our review has shown, the population density figures considered by earlier researchers were at the state level or at the regional level. Given the fact that such variations are often not remarkable, and that the cases of COVID-19 were mostly reported from cities during the first wave in India, considering the population density of the entire state does not make much sense. Instead, what mattered was what proportion of the people in each state live in heavily populated areas. Hence, the proportion of the state population which live in cities with population density more than 5,000 persons per sq. km was considered.

Another parameter considered was per capita income (the per capita net state domestic product). While it was found that the highly developed countries were worse off during the first and second wave of pandemic, studies in the United States had shown that the spread of the virus was higher in the vulnerable groups that include African Americans and Hispanic-Latina (Wong and Lee, 2020; Jin *et al.*, 2021).

The value of per capita NSDP (at constant prices) for the selected states of India ranged from a lowest of Rs. 43,870 for Uttar Pradesh to a highest of Rs. 3,37,745 for Goa, which is the richest state in India in terms of per capita income. Delhi stood second with a per capita NSDP of Rs. 2,69,505.

The third parameter considered was proportion of people above the age of 60, because studies have shown that the old age people would be more susceptible to the disease, as countries having aging population were badly hit (source: based on Gardner *et al.*, 2020; Upadhyaya et al., 2020). This is also one of the parameters used by Balakrishnan and Namboodiri (2021) in their analysis of variations in COVID-19 cases.

The estimates of COVID-19 infections ranged from a lowest of 2.5 persons per 1000 population for Uttar Pradesh to 34.7 people per 1,000 population for Goa. The second highest reported COVID-19 cases was for Delhi, with 34.2 persons per 1,000 population. Kerala had the third highest reported cases with 29.8 persons per thousand.

Analysis with number of COVID-19 infection cases per 1,000 people as a dependent variable, against these three independent variables showed an R^2 value of 0.643. All the three parameters had a very high level of significance (see Table 3) in explaining the variation in COVID-19 cases across states to an extent of 64%. The regression equation is:

COVID-19 cases per 1000 people = - 7.42 + (0.000062 * Per capita NSDP in INR constant price) + (12.45 * Proportion of population living in densely populated area) + (128.49 * Fraction of population above the age of 60)

As per the model, states with high proportion of people living in very densely populated areas (like Mumbai, Delhi, Ahmedabad, Kolkata, Chennai) and higher fraction of people in the old age category (above 60 years) would have higher cases of infections. In a broad sense, these findings corroborate with findings of studies available from other countries that were reviewed in this article about the effect of population density and aging population on Covid-19 infections. For instance, the first trend is in line with Jablonska et al. (2021) and the second trend corroborates with the findings of Upadhyaya et al. (2020) and Gardner et al. (2020).

But the study clearly shows that the average population density at the aggregate level does not mean much when it comes to explaining the inter-state differences. Though the R^2 value slightly improved (to 0.64) when the multivariate analysis was carried out with (state) average population density (along with the other two variables) against Covid-19 infection rates, the same dropped to a mere 0.51 when data for 'Delhi', which is an outlier[i], was removed from the sample. More importantly, the 'p value' for 'population density' increased drastically (to 82%), indicating that the variable is not significant at all. But the original model was run by excluding 'Delhi', the R2 value remained almost the same (0.62), with the significance of each variable improving. The effect of population density becomes imperative when the density exceeds a certain threshold and therefore what matters is what proportion of the population live in such densely populated areas. In this case, the proportion of people living in areas with population density higher than 5,000 persons per sq. km was found it to be a useful criterion.

Interestingly, higher average per capita income increased the incidence of COVID-19 infections. However, it should also be pointed out that the gradient is not steep. For income to have a real effect on the disease, the rise required is quite high, as the value of the beta coefficient is 0.000018. If the average per capita income increases by one lac rupees, there is chance that COVID-19 cases would increase by around 1.8 per 1,000 people.

A plausible explanation for this trend (contrary to what was found in other countries) could be that the average per capita income considered is of a state, and not of the pockets that are badly hit by the infection. That said, some of the states having high average per capita income are also states that are high exposure to international and domestic passenger footprint by virtue of having international airports (like Delhi, Kerala, Maharashtra and Goa), and heavy influx of migrants. This increases the infection risk. On the other hand, in some of these states (Delhi and

Maharashtra), a very high proportion of the people live in slums with much greater congestion, without basic facilities of proper water supply and sanitation. This further increases the risk of infection. It should be invoked that in Mumbai, it is the slums inhabited with millions of people that was badly affected, and the average income figures for the state (in this case, Maharashtra) does not reflect the socioeconomic conditions of these poor localities where most of the people are very poor.

Table 3: Result of multivariate regression analysis with COVID-19 cases per 1000 people as dependent variable and per capita NSDP, proportion of population living in densely populated areas, and fraction of population above the age of 60 as independent variables

Predictor	Coefficients	Standard Error	t Statistics
Constant	-7.42	4.34	-1.71
Per capita NSDP (INR constant prices)	0.000062**	0.000019	3.30
Proportion of population living in densely populated areas (above 5000 per sq. km)	12.45*	6.32	1.97
Fraction of population above the age of 60	128.49*	62.79	2.05
R-squared	0.643		
Number of observations	29		

Note: * and ** indicates significance at 90% and 99% level, respectively

The factors that we have not considered in the analysis are the environmental conditions. There is surely a lot of variation in the climatic conditions across the country, strong enough to cause variations in the potency of the virus to spread, if we go by the studies done in Russia and other cold countries. Coastal Maharashtra, especially Mumbai is very hot and humid. So is the coastal areas and midland areas of Kerala, Chennai, the plains of West Bengal and coastal areas of Odisha. Gujarat, Karnataka, Tamil Nadu, Rajasthan, Punjab, Haryana, Andhra Pradesh and Telangana are mostly in the hot tropics. Uttar Pradesh and Bihar lie in sub-tropical, temperate zone. The north eastern states have cold and humid climate. However, the effect of these climatic variations is not captured in the model owing to inadequate information on the way they could affect infection from the virus.

What Explains the Variation in COVID-19 Deaths?

A survey by the Office for National Statistics (ONS) in the United Kingdom found in their survey that the backward areas of England and Wales, with high Index of Multiple Deprivation, had the highest mortality rates during the initial days of the pandemic. The index takes into account factors such as an area's income, employment, crime and health deprivation and disability. The ONS study, which included 20,283 deaths involving COVID-19 in England, found the mortality rate in the most deprived areas to be 55.1 deaths per 100,000 population, against 25.3 deaths in the least deprived areas (*BBC*, 2020).

Different indicators were used by different states at different points of time to justify the actions taken to control COVID-19. For instance, one of the arguments made by the government of Kerala, while the state witnessed high incidence of COVID-19 when other states were showing a steep decline in the number of cases, was the low CFR (Case Fatality Ratio). In the case of Kerala, the CFR hovered around 0.40, i.e., 4 deaths per 1,000 COVID-19 patients, during the first wave. The low CFR brought down the overall deaths per 1,000 persons to a considerably low level in Kerala and Telangana which managed to keep the CFR

below 0.5 per cent. The overall deaths per 1,000 people is the multiple of no. of cases per 1000 people and the number of deaths per 1000 cases. When the number of cases of infections increases disproportionately in some states, the low CFR in those states may not be of much relevance as the total number of deaths would increase. More importantly, from the point of view of safeguarding public health, the pressure on the health infrastructure, which is expected to protect lives, would increase with increase in number of cases. Hence, we have used the overall deaths per 1000 people for our analysis.

We ran several regression models to understand the factors that explained the variations in COVID-19 deaths per 1000 persons across the states. After several iterations, a total of five variables were included in the analysis as independent variables, while many were excluded after noticing that either they have no effect in influencing the 'COVID-19 deaths per 1000 persons', or are related to the other variables already considered for the analysis. For instance, population density was found to have no effect on the COVID-19 deaths and hence was excluded from the analysis. The poverty rate was found to be inversely proportional to the per capita net state domestic product (with a high correlation coefficient) and hence was excluded.

The final variables chosen are: proportion of people living in densely populated areas (above 5,000 persons per sq. km); average public health expenditure by the state (during the past 9 years); per capita net state domestic product; the capacity of the health infrastructure; and fraction of the population in the age group of 60 and above. The average public health expenditure per capita was found to be varying from Rs 472 per annum in Jharkhand to a highest of Rs. 3500 + per annum in Sikkim and Goa. The health infrastructure per 1,000 people was found to be varying from a lowest of 0.588 in J & K to a highest of 3.88 in Karnataka (Figure 2).

The regression analysis showed that these factors together explained the variation in COVID-19 deaths to an extent of 74.5 per cent (R-square value=0.745) (Table 4). However, among these five variables, two variables, i.e., per capita NSDP; proportion of people living in densely populated areas had very high level of significance. The fraction of aged people in the society was significant at 13 per cent level and therefore should also be considered as important. Increase in aging population certainly increases the mortality rate, probably owing to weaker immune system and the chances of co-morbidities. The health infrastructure had lower level of significance (24 per cent level), whereas public health expenditure had an inverse effect in reducing mortality.

When the regression model was run by replacing 'proportion of people living in densely populated areas with 'average state population density', though the R2 value decreased marginally (to 0.72), many of the variables except population density became insignificant with p values becoming 85% for average PHE,. 43.5% for health infrastructure and 24.4% for proportion of population above the age of 60. This analysis suggests that the average state population density is not explanatory variable for Covid-19 deaths also.

The adverse impact of economic conditions on death rates can be explained by the phenomenon of high degree of mobility of the people and exposure of the population in some of the high-income states (Delhi, Goa, Maharashtra and Kerala) to heavy domestic and international passenger footprint, and a substantially large migrant population. These factors increase the risk of serious COVID-19 outcomes. Incidentally, in some of the states such as Maharashtra and Delhi, the proportion of people living in highly congested slums under extreme poverty with poor access to basic health infrastructure is considerably high. These factors also increase the chances of mortality.

Table 4: Result of multivariate regression analysis with COVID-19 deaths per 1000 people as dependent variable and average public health expenditure, per capita NSDP, proportion of population living in densely populated areas, health infrastructure per 1000 persons, and fraction of population above the age of 60 as independent variables

Predictor	**Coefficients**	**Standard Error**	**t Statistics**
Constant	-0.15	0.09	-17
Average public health expenditure (INR per capita)	0.000028	0.000030	0.93
Per capita NSDP (INR constant price)	0.00000094*	0.00000049	1.91
Proportion of population living in densely populated areas (above 5,000 per sq. km)	0.35**	0.11	3.20
Health infrastructure per 1000 persons	-0.029	0.025	-1.20
Fraction of population above the age of 60	2.12	1.34	1.58
R-squared	0.745		
Number of observations	29		

Note: * and ** indicates significance at 90% and 99% level, respectively

The negligible effect of health infrastructure, contrary to what was found by Tantrakarnapa *et al.*, (2020) for Thailand, in reducing the mortality rate needs explanation. As regards the effect of health infrastructure, one reason could be that the actual effect of such factors would be visible when the total number of cases crosses a threshold wherein the public health infrastructure collapses. This is what is seen during the second wave of COVID-19 infections. In spite of large number of cases per 1,000 persons, Kerala, which has one of the best public health infrastructures in the country, has been able to control the death rates to nearly 3 persons per 1,000 cases (CFR=0.3 per cent), and 1.75 persons per 10,000 population whereas the total number of deaths per 1000 infected persons in Maharashtra is 14.96 and the number of deaths per 10,000 population is 6.9. The death rate in Maharashtra today is nearly 4 times that of Kerala[ii].

As regards the negative effect of public health expenditure (PHE) on reducing COVID-19 deaths, the above phenomenon could partly explain, as many of the states incurring moderate to high expenditure on public health are also those having relatively higher NSDP (Delhi and Goa). This factor nullifies the benefit from high public health expenditure. An additional factor could be that not all people living in all areas get equal benefits of government expenditure on public health, especially in vulnerable areas in terms of public

health centres and community health centres and the number of staff equipped to handle the cases.

Concluding Remarks

Questions were raised during the past one year or so about the reliability of data relating to incidence of COVID-19 infections and deaths occurring in India by medical professionals, clinical scientists and social scientists around the world. Newspapers have occasionally reported incidence of underreporting of COVID-19 cases, especially deaths, by the state governments. Epidemiological studies on COVID-19 would require high quality data on infections and deaths. The issue relating to data reliability notwithstanding, the sharp variations in incidence of infections and death rates is a reality witnessed across Indian states. That being the case, analysis involving state-level data on COVID-19 and the range of factors that have potential bearing on the pandemic transmission and deaths can bring out certain key determinants of the variations in infection rates and death rates, if we assume that the extent of false reporting of infections and deaths is more or less same across the states.

Multivariate analysis involving state-wise data show that two important variables influence the infection rate, i.e., proportion of people living in areas with population density higher than 5,000 persons per sq. km, and the proportion of people above the age of 60. The effect of per capita NSDP was adverse. States with higher per capita NSDP had higher infection rates per 1,000 people. This probably explains the low occurrence of the infection in some of the states that are predominantly rural such as Uttar Pradesh, Jharkhand, Chhattisgarh and Odisha during the first wave of COVID-19 infections.

As regards COVID-19 related deaths, three main factors are found to influence. They are: 1) proportion of people living in areas with state's population density higher than 5,000 persons per sq. km; 2) fraction of population above the age of 60 in the state; and, 3) the per capita NSDP of the state. The fourth factor, which was less significant, was the health infrastructure from public and private sector. The status of health infrastructure though had negative impact on death rates, they had lower levels of significance. This could be due to the fact that the number of cases of infections in the states had not become high enough in the badly affected states to start showing the impact of poor health infrastructure and inadequate public health expenditure. As the data from the second wave of COVID-19 show, the states with poor health infrastructure and low level of state expenditure on public health do witness high death rates.

The scientific explanation for these factors to be important determinants of COVID-19 infection and COVID-19 death can be had from the knowledge available from past research. The most intriguing trend that emerged from the study, for which scientific explanation is hard to obtain, is the positive impact of the average economic conditions on COVID-19 infection rates and deaths. Unlike what was found in the studies elsewhere in the US and UK, high income increased both infection and mortality rates in the respective states. This was probably due to the increased mobility and associated problem of increased exposure of the people living there to domestic and international passenger footprint, and a substantially large migrant population. Incidentally, some of these high incomes states also had large and congested slums, and with poor access to water supply and sanitation and inadequate public health infrastructure.

The study highlights the need for shifting the focus of the COVID-19 control strategy to regions characterized by very high density of population and high income-inequality, or which have a high migrant population and have high degree of exposure to domestic and international air traffic, along with regions with aging population.

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[i] The reason for considering Delhi as an outlier is that it is the only state whose average population density figure is representative of the actual population density across its entire geographical area, unlike many other states which while having low average

population density, had large proportion of the people living in very densely populated areas.

[ii] As on May 15, 2021, the total number of cases in Kerala is 20.5 lac and that in Maharashtra is 52.7 lac. The total number of deaths in Kerala is 6150 and that in Maharashtra is 78,857. The population of Kerala and Maharashtra are 35 million and 114.2 million, respectively.

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Securing the Upside:
Pandemic Teaching and Learning Success Themes and Go-Forward Policy

Cliff Zintgraff[1], Megha Nangia[2], Uttam Panda[3], Gargi Sharma[4], Sadaf Siddiqi[5], Sampada Pachaury[6]

Abstract

This article explores themes of teaching and learning innovations that emerged or were reinforced during the pandemic. Some innovations have survived, and even thrived, and the authors believe they have a role post-pandemic. The authors explore these themes and recommend policy steps that can secure future benefits from this unwelcome but still hard-won experience. The themes emerged from discussion between a U.S. STEM researcher and five Indian education professionals whose backgrounds cover private schools, public schools, educational technology, science and technology informal learning, and policy. The themes are: improved access to teachers, improved access to content, and acceleration of supporting pedagogies. Various lenses are applied: technology, process creativity, real-world learning, self-efficacy and social-emotional learning, and the perspective of teachers. A lens of special note is the digital divide and ways innovations differed in their usefulness between those with resources and those without. A summary is provided of the student learning that has occurred despite the pandemic, or because of it—learning that is often hard to measure. Overall, teaching and learning have suffered greatly. Where gains have been made, the authors' greatest hope is to help secure them long-term.

Keywords: Teaching; Learning; Innovation; Pedagogy; Pandemic; Policy

Introduction

Teaching and learning have suffered greatly during the pandemic. During this time, over 1.2 billion children were out of classrooms in 186 countries in the world, and

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over 320 million students faced severe learning challenges (Li & Lalani, 2020). In India, 250 million students are of K-12 age (Powell, 2021).

Teachers have borne the brunt of the pandemic teaching challenge. Many have worked longer hours, with some being available constantly both during and outside formal hours. Many have done so on reduced salaries or faced furloughs (if they did not lose their job outright) (Bose, 2021). Some had to purchase their own devices to continue teaching. Meanwhile, teachers innovated, both individually and collectively. They did so in an environment that changed overnight and with little or no training for new demands. They dealt with imperfect technology, lack of student physical connection, reduced student engagement, and increased parental intervention. Teachers' challenges have been large.

Ultimately though, this paper is not about the massive challenges faced by students and teachers in India, South Asia, the U.S., or worldwide. The context described is important, but the challenges are well documented elsewhere. Rather, it is a search for themes of innovation that emerged or have been reinforced during the pandemic. Bell (2021) reports that 'many schools are already evaluating what things worked and how to maintain them when the pandemic eventually ends' (In-class learning isn't best, para. 1). The authors have sought innovations that survived, at some level thrived, and deserve to be sustained. These innovations and the ideas they represent are too hard-won to be let go.

The research paradigm used is *critical theory* (Guba & Lincoln, 1994), a theoretically based approach that allows for participant researchers who both observe the system and are within it. The list of authors includes a U.S. STEM researcher and five Indian professionals whose backgrounds cover private schools, public schools, educational technology, science and technology informal learning, and policy. The authors started with the overarching question 'what teaching and learning developments should survive the pandemic?' and progressed through iterations of live and asynchronous discussions. The final article reflects the themes that emerged, and it reflects the lenses the authors found themselves applying. The themes and lenses rise beyond anecdotal evidence and show themselves true at some scale in India, South Asia, the U.S., or global settings.

Three themes emerged. First, some innovations provide improved access to teachers. Second, some innovations provide improved access to content. Third, some innovations accelerated use of 21st century pedagogies, especially those emphasizing real-world learning and learning in context.

The three themes focus on outcomes. The outcomes we observed were all were reached through various tools and techniques of the teaching trade, which the authors used as lenses for observation. For example, technology has played an essential role in enabling access. Other lenses are process creativity, real-world learning, self-efficacy and social-emotional learning, and the perspective of teachers.

A lens of special note is the digital divide. Some innovations mostly benefited people with resources. People lacking resources struggled more. Still, they

occasionally found their own ways to achieve some level of benefits. Table 1 summarizes the themes and lens of observation.

Table 1. Themes of at-scale pandemic innovations; lenses of observation

Themes	Lenses of Observation
Improved access to teachers	Technology
Improved access to content	Process creativity
Acceleration of 21st century pedagogies	Self-efficacy and social-emotional learning
	Perspective of teachers
	The digital divide
	Hard-to-measure student learning

A powerful way to understand impact is to explore student learning. While the authors acknowledge that student learning commonly measured has suffered, the authors argue that hard-to-measure learning benefited in a myriad of ways.

What is the fate of these innovations? The pandemic has caused negative disruption at massive scale. Meanwhile, smaller disruptions for individual students, teachers, schools, and regions have always been a reality. There is use for these innovations post-pandemic, and new concepts of operation that can integrate their use. In fact, innovations in teaching and learning have never been about the innovations per se, but about their integration into school systems that benefit students, parents, teachers and administrators (Mishra & Koehler, 2006; Ganimian et al., 2020). Many innovations have received an unplanned injection of energy. The authors recommend policy steps to help secure these hard-won learnings.

Innovation Theme: Access to Teachers

The role of teachers in education is both obvious and well researched (e.g., Cuban, 2001). Teachers are professionals at developing students from their current level of knowledge to new levels. Teachers understand the challenges students face and how to help students address them. Those challenges are intellectual in nature, and also social, emotional, and grounded in their lives outside the school day.

Reconnecting teachers to students has been a major priority. Both technology and creativity have been abundant, even if the results represent an incomplete replacement. Necessarily, some of these innovations also connect students to content, a topic covered in the next section.

Technology solutions

Stating the obvious, technology has been fundamental to addressing pandemic challenges. Developments in ICT have made this application of technology possible.

Live video

In settings with resources, live video—most often Zoom (Joia & Lorenzo, 2021)—has been prevalent. Classes are conducted live; many if not most students are live on

video, and with the ability to share screens. Tools like polling can inspire engagement. Live chat complements the experience and gives students of different personalities and aptitudes another way to communicate. Some classes are online only, and others in a live-hybrid format (a format many teachers have found difficult, like having two different jobs (Mason, 2020; Ferlazzo, 2021)).

WhatsApp and other text-based solutions

While WhatsApp can support video, its prevalent use is for messaging. It is prevalent for group messaging, given the easy/free access on smartphones, used for text, image, and file-based conversations, and also for content distribution. In India, WhatsApp was used in 75% of government schools and 57% of private schools (Vyas, 2020).

Learning management systems (LMSs)

Learning Management Systems play a special role in organization of content, and they provide an asynchronous means for teacher-student communication through messaging, especially through discussion boards.

The basics: email and text

One must not overlook these basic methods of connection. The authors know from experience that many teachers simply email students and parents or use built-in phone messaging. It would be fascinating to research what percentage of contacts between teachers and students/parents used these methods.

Non-ICT Innovation

In other cases, access to teachers has been about process creativity—finding non-ICT ways for teachers to connect. In Chhattisgarh in Central India, where infections were relatively low in the first wave, educators started Mohalla (neighborhood) classes. Teachers spent two hours in a room with students. In Dumarthar, a remote tribal village in Jharkhand, whole village walls were converted into blackboards for teaching (Vyas, 2020).

Teachers go mobile

In other cases, teachers very intentionally went to students. The idea is not new. School on Wheels is a 28-year program in California, USA, serving 50,000 students and focusing on high-needs communities (School on Wheels, 2021). A program of the same name was started in India to address pandemic challenges. Teachers travel in a mobile school with material and assignments. Students are instructed and parents

receive guidance. Assignments are checked in further visits. The program serves students from Kindergarten to 5th grade (Asheesh, 2020).

Innovation Theme: Access to the Right Content

Access to content is a distinct theme. Numerous methods have been used to deliver content. Many methods use the same approaches connecting teachers to students: video sessions, WhatsApp, Google Classroom, LMS platforms, and email and smartphone messaging.

Recorded videos

Recorded videos have been highly used. They fall into different categories, including videos from the Internet (e.g., YouTube), recordings specifically made by teachers for their students (Rasmitadila et al., 2020; Bond, 2020); and recording of class sessions. Recorded videos offer advantages previously documented: playing and replaying on demand; accessing content whenever needed (for example, when studying for exams); and viewing independent of specific times and geography (Malhotra, 2021).

Large scale/government portals

Some governments and agencies have launched large-scale digital platforms. An example is Diksha, launched by the Indian government in 2017 (Sharma, 2021). The platform has been a focus of effort during the pandemic, accessed by both teachers and students. In addition to lessons, worksheets, videos and more, there is material about 'mental well-being and inclusive classrooms' (High Quality Learning Material, para. 2). The government reports an average of three crore (30,000,000) hits per day since March 2020.

Process innovation

Educators have found ways to deliver content using old technologies, or no technology at all, especially in locations lacking ICT. In Ethiopia, Save the Children created the Camel Library. They reached 22,000 children in 33 villages with 21 camels carrying up to 200 storybooks in wooden boxes (Railway Children India, 2020).

In very different settings, the U.S. and Ethiopia, initiatives are using television and radio. In the U.S., programs are broadcasting teacher-generated educational content, including in the states of New Jersey, Nebraska, and New Mexico (Catalini, 2020). In Ethiopia, Save the Children secured nine satellite television channels that reach 8 million children with materials developed by regional bureaus and the national Education Ministry (Sewunet, 2020).

Again, one must not overlook basic solutions. In Daman and Diu, India, a campaign delivered worksheets to parents using basic methods of distribution; for example, administrators delivering content to students' homes (Department of School Education, 2020).

Making Choices: The Right Content

Amid tectonic shifts, educators had to choose which content to keep and which to omit—an immediate problem, but a long-term opportunity. Debates about breadth versus depth in education—about content 'a mile wide and an inch deep'—are longstanding (Schmidt, McKnight, & Raizen, 2007, para. 2). Choices made under duress by teachers represent an opportunity to 'selectively focus on fewer lessons in more depth…a model for when school campuses reopen' (Fensterwald, 2021, para. 4) and was welcomed by some teachers.

Innovation Theme: Acceleration of 21st Century Pedagogies

The challenge of pandemic teaching has, at times and by necessity, led to pedagogies consistent with the teaching of technology and 21st century skills.

Technology integration

It is beyond obvious that the pandemic has driven technology's use in learning. Comments from teachers indicate: (1) much learning about remote teaching tools, by teachers and students; (2) an injection of energy in regions lagging; which (3) led to re-evaluation of teaching methods.

Teacher skills in integrating technology, pedagogy and content

To use technology well, teachers must understand how to integrate technology, pedagogy and content. TPACK (Mishra & Koehler, 2006) is a well-researched model for how teachers become skilled at this integration. Bond (2020), in a meta-analysis of pandemic teaching research, said 'even experienced teachers struggled with making the switch to remote online learning' (p. 206). Hodges et al. (2020) described how we must view pandemic teaching as an evolution from pre-pandemic teaching, to *emergency* remote teaching, and then to more careful first redesigns. Regardless, the pandemic has accelerated teacher efforts to integrate these skills.

Interaction and student engagement

The strongest pedagogical theme observed was keeping students engaged—a massive challenge—'[some] students...completely checked out' (Osborne, 2021, Lack of student engagement, para. 1). In other cases, it has been worth the effort—students 'join Zoom…they are learning' (Some students thrive, para. 3). Beyond ICT, Ferlazzo (2021) described visiting the porches of students' homes to engage with students and parents and learn about their community. Weiss and García (2021) quoted teachers about the importance of their connection with students:

> ...relationships and connection matter most…building connections with students can happen virtually…Connection. Connection. Connection…it has proven true over and over again…it's connection, not content, that counts. (Connection is critical, para. 1).
>
> Many educators found that grace and connection were the keys to navigating the challenges of the pandemic (para 1).

Student Learning That Thrived

Learning losses have been serious. Even a 'best-case' scenario (Engzell et al., p. 1) from the educationally-advanced Netherlands showed a one-fifth loss in learning. A 60% greater loss was reported in less educated homes.

Still, from critical discussion and literature, the authors argue for increased learning in selected areas. These areas reflect the real-world concerns of the pandemic, consistent with the notion that real-world learning is powerful. This learning demonstrates constructivism in action, where each student has a unique knowledge starting point, and students possibly learn different things. Such learning is more difficult to assess, but highly relevant. The learning observed generally reflects the so-called 21st century skills, and the 4 Cs: communication, collaboration, critical thinking, and creativity.

Emergency response

The authors agreed that children learned deeply about how to respond to emergencies in life. Parents engaged their children in matters of finances, domestic affairs and the dynamics of survival. On one hand, these were the *relative emergencies* of people with means. On the other hand, they were literal life and health emergencies for people of low and high means.

Technology learning

Students learned much about using technology for communication and education. Daily use requires not only basic skills, but the ability to navigate technology tools and solve inevitable problems. Fensterwald (2021), quoting a third grade teacher in California, U.S., said:

> A lot of the learning we've done this year – how to use technology…I think my students understand really deeply. (para. 13)

Learning about science, evidence, and global connectedness

Students have personally witnessed the response of professionals and the impact of science, evidence, and how people are connected. Students have seen the positive

and negative elements of this phenomenon. The global efforts to discover vaccines and drugs represent positive learning for students. Students have seen acceptance of evidence, rejection of evidence, and legitimate debate. They have seen illegitimate debate over issues. It is an exam far more real than those usually sat for by students.

Health learning

The pandemic has shown the necessity of hygienic and healthy habits, from washing hands to using sanitizers and healthy eating. Students have learned about vitamin-rich food, and they learned to avoid risky social settings or to be safe in them. They learned the importance of staying fit since obesity is a COVID comorbidity.

Mental health learning

One way to manage mental health is to achieve self-efficacy around topics. For some students, the pandemic has been a route toward self-efficacy. Osborne (2021) reported observations of students who 'learned to be more independent and manage their time better' (Some students thrived, para. 7). Other students experienced less peer pressure and bullying. Even for students who found the situation more stressful, many learned about taking care of their mental health; for example, through UNESCO's Minding our Minds campaign (Loiwal, 2020).

Of Great Significance: The Digital Divide

The authors intentionally saved most issues of the digital divide for this section. All students have faced pandemic challenges. That said, the challenges of those with means differed greatly from those without.

For example, consider this paragraph from the authors' development of this paper.

> The availability of the Internet, of affordable internet resources and 4G data packs, and of smartphones at affordable prices, are some reasons for the sudden peak rise of online education in India…the main advantages of online classes are: quick access, comfort of learning from one's home, convenience, flexibility, reduced cost, improved communication skills, better teacher-student interaction. Stronger teacher-student bonding facilitated the teaching and learning process.

This contains truth for students of means. It will sound like nonsense to a student, parent or educator without means. Such students struggled to find phones and reliable Internet. Their experience was hanging from trees ('tree classroom') to get cellular signals (Railway Children India, Tree classroom, para. 1), or of using their fathers' maybe-smart-phones for school (at least until fathers found themselves at work during later waves) (School Principal, personal communication, June 2021).

Data makes clear the reality in India. One in ten households have a computer. One-quarter have Internet access. In cities, 42% have Internet access. In rural India, 15% have that capability (*The Hindu*, 2020). It is no surprise that Vyas (2020) highlighted 'tech-free innovations' like the Mohalla (neighborhood) classes (So, what can be done?, para. 1) , or delivery of printed workbooks, or turning a whole village into an open classroom. Policy prescriptions must try to close the digital divide moving forward, but they must also account for it now.

Policy Recommendations

The following are recommended policies that might be carried out at the school, city, regional, state or national level to secure teaching and learning wins. Implementation can happen along a continuum from lesser to greater interventions, from removing disincentives, to providing incentives, to providing support structures, and finally to providing programs (Wilson, 2005). Dissemination of results accompanies all recommendations made below.

1. Leverage pandemic learnings into post-pandemic systems
    a. The ICT Highway

    Use new/improved delivery mechanisms as highways to deliver content to underserved communities. Examples include WhatsApp, Zoom, Google Classroom, and other ICT tools. Imagine more vocational education, skill development; remedial learning programs; and accelerated learning programs delivered to these communities, and the resulting impact.

    b. Students, and Parents

    Whenever new delivery methods are used with students, deliver complementary guidance to parents to help them help their wards (students).

    c. The Old Disruptions

    Identify where new delivery methods can help with traditional disruptions; for example, students out sick, teachers caring for family, etc.

    d. A Mile Deep, An Inch Wide

    Research the decisions teachers made about what content to keep and what to skip, and where it improved experiences; make changes permanent.

2. Celebrate and leverage pandemic teaching heroes
    a. Teaching Heroes as Fellows

    Identify local education heroes of the pandemic and create an Innovation Fellows program to secure wins and drive innovation.

    b. Master Teacher for Online Instruction

    Identify and develop the most effective online teachers in public and private systems and for underserved populations.

3. Bring fresh research focus to the teacher-student relationship and student engagement

a. Re-examine through research the teacher-student relationship

Do this in light of the pandemic experience, including main elements of the relationship. Disseminate findings.

b. Teacher-Student Relationship and Technology

Research, document, and disseminate findings on best practices of how teachers maintained relationships with students via technology. Prepare and deliver related training.

4. Re-evaluation in light of the pandemic

a. The Pandemic and Assessment

Conduct research that re-evaluates assessment methods in light of the pandemic experience.

b. The Pandemic and Social-Emotional Learning

Use lessons from the pandemic to reconsider the balance between academic, social and emotional learning.

5. Research and disseminate other learnings to widen adoption

a. The Best National Content

Conduct research to determine which national government content was most useful, and why. Redouble the efforts to disseminate that content. Publish findings that can inform new content.

b. The Pandemic, Video, and Flipped Classrooms

Disseminate what worked in recorded video; advocate and train to accelerate adoption, especially toward implementation of the flipped classroom.

c. The Pandemic and ICT Tools

Research what worked with WhatsApp, Zoom, Google Classroom and other non-technology solutions, across all communities. Advocate and train to accelerate adoption in underserved communities.

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Young Voices

Modular Open-Source Identity Platform (MOSIP)

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Abstract

In a rapidly changing world of technology, the significance of a legal identity in securing a person's status before the law cannot be underrated. Digital identity systems have the potential to significantly accelerate access to formal identity and enable more inclusive and equal participation in the digital economy. It is thus critical to ensure that 'good' ID is adopted by governments and service providers: ID that empowers individuals to receive the benefits of a formal identity, while ensuring adequate safeguards against misuse. This article describes how Modular Open-Source Identity Platform (MOSIP) as an open-source platform meant for governments or international organizations to build a foundational identification system in a cost-effective way as well as to ensure that digital identification programs are governed in such a way that is inclusive, safe and empowering to individuals. It has the capacity to set an example for the rest of the world.

Keywords: Technology; Modular Open-Source Identity Platform (MOSIP); Digital identification; Governance; Safeguards

In this rapidly changing world of technology, there has been growing recognition that a legal identity (ID) forms the first step in securing a person's status before the law. In recognition of the fact that over a billion people globally lack formal identity, the UN Sustainable Development Goal 16.9 calls for "By 2030, provide legal identity for all, including birth registration". Because technology serves as an exceptional amplifier of both positive and harmful effects, digital identity systems have the potential to significantly accelerate access to formal identity and enable more inclusive and equal participation in the digital economy. It can also work to concentrate power in the hands of identity issuers, and perhaps other stakeholders in the data ecosystem.

It is critical, therefore, to ensure that 'good' ID is adopted by governments and service providers: ID that empowers individuals to receive the benefits of a formal identity, while ensuring adequate safeguards against misuse. A digital

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identification system is important for people who want to apply for the welfare schemes offered by the government.

MOSIP as an option

Modular Open-Source Identity Platform (MOSIP) is an open-source platform meant for governments or international organizations to build a foundational identification system in a cost-effective way. A functional identity system enables individuals to get a unique identity from the government to avail various services such as financial, social security, etc. Nations can use the platform when they want to build their own identification system. It provides a vendor-neutral and interoperable approach allowing governments to configure their systems with high accuracy. Apart from that, the platform gives ways to address various challenges when building a national functional system that helps meet the essential needs.

It has been created as a global public good - a core for foundational digital identity systems that enable the issuer to accelerate progress towards inclusive, privacy-centric and secure digital economies. To make this a reality, key enablers need to be in place:

- A legal and governance framework for digital ID that is designed to be inclusive and to prioritize users' control over their information.
- Transparency and wide stakeholder participation in the decision-making process.
- A system that prioritizes privacy and user control, is secure and uses open standards.

Key Architectural Principles of MOSIP

MOSIP started being developed in late 2018 by the International Institute of Information Technology, Bangalore (IIIT-B). It is funded by the Bill and Melinda Gates Foundation, Tata Trusts and Omidyar Network. The project is governed by an Executive Committee and a Technology Committee. The former advises and guides IIIT-B on matters of project governance, finances, intellectual property, etc. The latter is responsible for all technical decisions, including the product roadmap and open-source community management.

MOSIP endorses and works actively to implement the Principles on Identification for Sustainable Development, which set out a path to creating an inclusive, user-centric and secure identity system. These principles have been backed by a wide-ranging group of organizations, including the Asian Development Bank, the Bill and Melinda Gates Foundation, the Center for Global Development, Omidyar Network, Mastercard, Secure Identity Alliance, GSMA, United Nations High Commissioner for Refugees, United Nations Development Programme, United Nations Economic Commission for Africa, and the World Bank Group.

MOSIP platform comes with independent and interchangeable modules with API-based implementation. Some of the key modules include pre-registration, registration client, registration processor, ID repository and ID authentication. Those who want to develop a digital identification system can use any of or all the modules that help a lot to experience the desired outcomes. Additionally, it makes feasible methods to focus more on the objectives that will help accomplish goals to a large extent. The platform even contributes to integration with existing databases or present different flows, thereby showing ways to make the project successful.

Inclusion (Universal Governance and Accessibility)

1. Ensuring universal coverage for individuals from birth to death, free from discrimination.
2. Removing barriers to access and usage and disparities in the availability of information and technology.

Design (Robust, Secure, Responsive, and Sustainable)

1. Establishing a robust, unique, secure, and accurate identity.
2. Creating a platform that is interoperable and responsive to the needs of various users.
3. Using open standards and ensuring vendor and technology neutrality.
4. Protecting user privacy and control through system design.

Governance (Building Trust by protecting Privacy and User Rights)

1. Safeguarding data privacy, security, and user rights through a comprehensive legal and regulatory framework.
2. Establishing clear institutional mandates and accountability.
3. Enforcing legal and trust frameworks through independent oversight and adjudication of grievances.

Features of MOSIP

MOSIP open-source platform comes with different features and users should know about them in detail. Moreover, it allows government organizations to perform several tasks with ease.

1. Scalability and manageability

The primary advantage of MOSIP is that it gives ways to work on population and improves the functions when technologies evolve. Most open-source platforms come with vertical scaling that will result in high expenses. Not only that, they consume large capacity and storage. Vertical scaling also plays an important role in limiting the overall scaling ability that requires immediate attention. MOSIP is horizontally scalable that provides ways to scale out accordingly. The platform

comes with other features such as monitoring, auditing and upgrading to overcome unwanted issues.

2. Privacy

MOSIP platform is available with security and privacy features that will help protect the data from potential threats. The consent framework in the platform takes care of user privacy that lets users choose what they want to share and when. Apart from that, it enables users to lock authentication features that pave the ways to reach the next levels.

3. Security

The platform makes feasible methods to encrypt all the information that is inaccessible by both external and internal parties without user content. Some other security features include license keys, policies, and infrastructure security that will help minimize potential risks.

4. Cost-effectiveness

MOSIP platform is a cost-effective solution for all government agencies that allow users to leverage the costs effectively. It provides ways to design a system at affordable rates, thereby showing ways to reduce expenses.

5. System integration

Users can integrate the system with configuration-based approaches, which pave ways to develop an ID with high efficiency. Besides that, it allows them to design a system based on their choices.

6. Vendor neutrality

Vendor neutrality is important for government agencies to manage the customer's labour ecosystem. It allows users to keep the ecosystem healthy, thereby helping to avoid potential risks. The MOSIP platform gives ways to avoid log-in by addressing the essential needs of users.

7. Modularity

Every major feature of the platform allows users to handle them as a separate plug that gives ways to perform the activity without any difficulties.

8. High performance

The MOSIP platform is available with infrastructure and networks that contribute to improving the performance levels effectively while performing important activities in identity platform designing.

Modules of the MOSIP platform

The MOSIP platform comes with modules such as user-enabled data entry, appointment booking, fingerprint, IRIS, photo, field configurability, UIN generation, data enrichment, etc. Modular de-duplication engine, e-KYC services, tokenization, virtualization, resident services portal, reports and analytics, resident controlled privacy, field configurability, appointment booking, online mode, offline mode and so on.

MOSIP is compatible with all operating systems, which support Java language allowing the users to design and build an identification system depending on their needs. The platform is easy to use that gives ways to design digital identity cards with unique features.

MOSIP includes features such as demographic and optional biometric de-duplication. In **demographic de-duplication** the MOSIP system compares some of the demographic data (i.e. Name, Date of Birth and Gender) of the resident against the data present in MOSIP System (the residents who have already registered in MOSIP). If any potential match is found, the MOSIP system sends the resident's biometrics to the ABIS system to confirm if the biometrics is also matching.

In **biometric de-duplication** the MOSIP system sends the biometrics of the resident to an Automated Biometrics Identification System (ABIS) System. Here, the expectation from the ABIS system is to perform biometric de-duplication (1: N match) against all the records that it has stored earlier. When biometric duplicates are found in ABIS, MOSIP system sends a request for Manual Adjudication to the Manual Adjudication System via a queue.

However, in these national ID systems, biometric de-duplication is problematic. Not only from a potential data protection perspective, but also from a purely functional point of view. The larger the sample size of users, the more manual adjudications need to be performed and the more evident it becomes that the uniqueness of biometric identifiers cannot be guaranteed; therefore, sabotaging the one principle that biometric de-duplication relies on.

Adopting a participatory approach and building trust

Many countries have initiated digital identity programs in the last decade, but in many of these attempts, adoption has been low. While reasons may vary, a recurring theme has been the lack of trust in a new ID system - an element that, when missing, poses the risk of derailing identity programs entirely. While recognizing that different countries, organizations, civil society groups, open source developers and business groups are in vastly different stages of awareness and readiness with respect to the key enablers mentioned above, MOSIP encourages governments and other ID issuers to adopt a transparent and participatory approach when making decisions about their identity systems. Open-

source solutions such as MOSIP carry with them an ethos of visibility into decision-making, receptiveness to constructive inputs and engagement with diverse voices, that we hope will carry through to the implementation of MOSIP-based systems as well, and enable the creation of a good ID system.

MOSIP will be used in a number of different countries and situations. Governments, international and regional organizations, civil society, open-source developers and businesses will all play different roles in the implementation and use of MOSIP. MOSIP intends to work with ID issuers to ensure that ID programs are inclusive, safe and empowering to individuals, and set an example for the rest of the world.

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Book Review

Foraging an Audacious City: *A Participatory Perspective*

Gautam Deb, 2021, Dasgupta & Company Private Limited, Kolkata; pp. 190, ₹ 700, Hardcover

Mahalaya Chatterjee[1]

Planned cities started in Britain with the Garden City movement. The main idea was to build cities with limited population with sufficient amenities and environmental considerations to do away with the ills of Industrial Revolution, with squalor, filth and chimney smoke. It was taken to a different height by the former Soviet Union. They built new cities to accommodate industry, academic institutions and sometimes agriculture. The same model was followed by other East European countries in the socialist block (especially Poland) and even China (in the fifties of the last century). The government or its subsidiaries were the main force behind the construction of such a planned township. Of course, they had their counterparts in the capitalist countries, but they were generally built by the land developers with private initiatives. India also had some instances of planned townships in the colonial period, especially by mining companies and plantations. But it was in the post-independence India that planned townships came into existence mainly to serve three purposes: i) industry: steel townships like Bokaro, Bhilai, Durgapur; ii) administration: starting with Chandigarh and Bhubaneswar followed by Gandhinagar and Dispur; iii) refugee resettlement and metropolitan extension: towns like Yamunanagar and Nilokheri in the western part, Kalyani in the eastern part. And that were the golden days of Nehruvian planning. In West Bengal, Durgapur and Kalyani were constructed in late fifties of the last century. In the sixties, a part of the Salt Lake in the eastern part of the city of Kolkata was filled up with clay from River Hooghly and the Salt Lake City (presently Bidhannagar) was planned mainly to decongest Kolkata. And the port city of Haldia at the downstream of River Hooghly served as an auxiliary port in mid-sixties. After that, there was no more attempt to build any other planned city in the state. After the Left front government assumed power, its urbanization policy was based on decentralization. There was conscious attempt to decrease the primacy of Kolkata and other urban areas in Kolkata Metropolitan Area. The budget allocation for non-KMA municipalities were increased considerably and the urban local bodies (ULBs) were strengthened with technical and other manpower. Regular elections were held to encourage participatory democracy. However, with opening up of the economy in the nineties, there was

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again a pressure to increase the supply of housing for the neo-middle class. Gautam Deb was the minister for housing at that time. West Bengal Housing Board was constructing saleable housing units in different parts of West Bengal on its own effort. With the winds of liberalization, it ventured into a public-private partnership (PPP) model with some leading realtors of the state. But of course, that was not adequate. One evening, while returning from Basirhat (his electoral constituency in eastern part of North Twenty-Four Parganas) he took a route from the Dum Dum Airport which was through an almost barren stretch of land and the only light was that of Bidyut Bhaban, the headquarters of West Bengal State Electricity Board in central part of Bidhannagar. And there was a spark in his mind to build up a township there. This book is a description of constructing the city – Newtown Kolkata.

It must be noted that the book is not an academic discourse. Of the twelve chapters, the first provides an autobiography of the writer, his transformation from a student leader to a minister in the Fourth Left Front Government. And the second is about the urban situation in West Bengal in the early nineties. Other ten chapters are about conceptualizing the Newtown, identifying the problems and finding the solutions for them. The first hurdle was to get the land, and the process followed here was buying land from the owners at market price and at the same time rehabilitating the people there. The young people were encouraged for alternative means of livelihood, especially setting up small enterprises. Secondly, the efforts of the government may encourage the landsharks in the surrounding area and the resultant push in land price along with haphazard construction would massacre the whole idea of planned township. So, a parastatal Bhangar-Rajarhat Development Authority was created to control the land use and development in the neighboring area. Thirdly, there was a conscious effort to not overburden the government exchequer and public-private partnership was the preferred model for big housing projects. Cooperative ownership of land was encouraged (of course, there were some plots for individual ownership). Fourthly, ideologically people at the lower rung of the ladder were the focus of planning. So, EWS housing was given the priority. People from the adjoining villages were involved in the process through formation of Neighbourhood Development Committee. Fifthly, the city was built for new the millennium and the infrastructure especially the fibre cable network was planned accordingly. Non-renewable energy like solar power was given priority.

Landfilling was done by raising sludge from the fisheries of East Calcutta Wetlands, which was a synergic method to help the fisheries. The irrigation department was involved for constructing a drainage system which also involved nearby Bagjola and Keshtopur canals. Even at one point it was thought that the Keshtopur canal will be utilized for drinking water and transportation by fiber glass boats. It did not materialize, but that is a different story. Another novel plan was to build up a self-sustaining solid waste management system, which would recycle the land periodically. The foundation stone of the New Town (then called New Calcutta) was laid by the then Chief Minister Jyoti Basu on June 1, 1995. West Bengal Housing Board was initially in charge of the project but later West Bengal Housing and

Infrastructure Development Corporation (HIDCO) was formed to carry on the task. New Kolkata Development Authority was also constituted to provide amenities and services. The major arterial road and the water bodies were constructed and land plots began to be allocated through lotteries. And thus, came up the audacious city of 'New Town'. With the change of guard in West Bengal, some of the conceived projects did not materialize as the priorities changed with the new government.

If one looks at the book critically, there may be a number of shortcomings. The author is writing in first person, he mentions names of peoples who have helped him. There should have been a short note about them. Chronology is not maintained which confuses the reader. To the general reader, some portions may seem like agenda of a political party. Of course, the passion with which the book is written would allow a critical introspection of the process and their consequences. The plus point of the book is the documentation of the birth of a planned township by government initiative, may be one of the last one of the genres. It serves as an important resource to anyone who is interested to know about city formation in general, and about Kolkata in particular.

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